Influence of Situational Context on Language Production: Modelling Teachers' Corrective Responses.

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Abstract

Natural language is characterised by enormous linguistic variation (e.g., Fetzer (2003)). Such variation is not random, but is determined by a number of contextual factors. These factors encapsulate the socio-cultural conventions of a speech community and dictate the socially acceptable, i.e. *polite*, use of language. Producing polite language may not always be a trivial task. The ability to assess a situation with respect to a hearer's social, cultural or emotional needs constitutes a crucial facet of a speaker's social and linguistic competence. It is surprising then that it is also a facet which, to date, has received very little attention from researchers in the natural language generation community.

Linguistic variation occurs in all linguistic sub-domains including the language of education (Person *et al.*, 1995). Thanks to being relatively more constrained (and hence more predictable with respect to its intentional aspects than normal conversations), teachers' language is taken in this thesis as a starting point for building a formal, computational model of language generation based on the theory of linguistic politeness. To date, the most formalised theory of linguistic politeness is that by Brown and Levinson (1987), in which *face* constitutes the central notion. With its two dimensions of Autonomy and Approval, *face* can be used to characterise different linguistic choices available to speakers in a systematic way.

In this thesis, the basic idea of *face* is applied in the analysis of teachers' corrective responses produced in real one-to-one and classroom dialogues, and it is redefined to suit the educational context. A computational model of selecting corrective responses is developed which demonstrates how the two dimensions of *face* can be derived from a situation and how they can be used to classify the many linguistic choices available to teachers. The model is fully implemented using a combination of naive Bayesian Networks and Case-Based Reasoning techniques. The evaluation of the model confirms the validity of the model, by demonstrating that politeness-based natural language generation in the context of teachers' corrective responses can be used to model linguistic variation and that the resulting language is not singnificantly different from that produced by a human in identical situations.

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Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(*Kaśka Porayska-Pomsta*)

To Keith and Michaś

Table of Contents

List of Figures

List of Tables

Chapter 1

Introduction

The focus of the current thesis is on developing a computational model of teachers selecting corrective responses to students' erroneous actions. The focus is placed specifically on modelling teachers' corrective responses as dictated by certain rules of linguistic politeness. Because such corrective responses can be potentially damaging to students' motivation and thus may have a negative impact on their learning, the decisions involved in choosing the appropriate way in which to correct the student are deeply embedded in a teacher's competence as an educator, as a speaker and as a socially and psychologically aware individual. The main challenge lies in every teacher's obligation to be educationally constructive, that is to promote a student's cognitive development above all and despite any difficulties, be it physical or socio-psychological, that a student may exhibit during learning. A skilled teacher will not only gear the structure and difficulty of the content matter according to the socio-psychological requirements of individual students, but also she will tailor her use of language to those requirements. Exactly how a teacher chooses to structure the content matter and what sort of language she uses depends on the *strategy* that she assesses as optimal for addressing a current situation.

Traditionally, in education a strategy is associated with a teaching method, which may also dictate the type of linguistic choices available to a teacher (Collins and Stevens, 1991). Thus, the instruction may be directly informative with respect to the subject matter taught (*Didactic Tutoring*), it may be expressed in terms of leading, sometimes highly structured questions (*Socratic Dialogues*), specifically it may be manifested in the form of pumping type questions, hints or spliced responses, amongst many other forms (Graesser *et al.*, 1995). Each teaching strategy may be realised by a multitude of different syntactic forms. For example, all of the teacher responses in 1.3 could be produced to the context provided by 1.1 and 1.2, and, according to Graesser *et al.* (1995), all of them could potentially be used to *scaffold* the student in a Socratic type of dialogue.

Context:

(1.1) **T's question:** What is needed to light a light bulb?

(1.2) **S' answer:** Heat (*incorrect answer*)

Teacher's possible corrective responses:

(1.3) (a) No, that's incorrect.

(b) Well, why don't you try again?

(c) Well, if you put the light bulb in the oven, it would get a lot of heat, but would it light up?

(d) Is it heat or the source that is needed to light a light bulb?

(e) In what way is the heat needed to light a light bulb?

(f) OK, let's take it one step at a time. What do you think is the most important thing that a light bulb needs in order to light up?

That teachers' language is characterised by significant linguistic variation constitutes a generally recognised fact amongst educationalists concerned with analysing educational discourse. Despite this recognition there is no systematic account of the sort of linguistic forms that belong to any of the mentioned methods in particular, that could be used as a guide to selecting similar forms in human-computer interaction. Moreover, none of the existing accounts provide a systematic basis for determining the influence of socio-psychological as well as of other contextual aspects on teachers' use of language.

Research in socio-linguistics, primarily that concerned with *linguistic politeness* (Brown and Levinson, 1987) brings to light a slightly different interpretation of strategy which is nevertheless compatible with that adopted in education. In this interpretation a strategy, henceforth referred to as a *communicative strategy*, is a socio-cultural phenomenon which is established by a particular speech community for the purpose of maintaining cooperation and communication between members of that community. A strategy is a form of rule which informs a speaker as to the best, i.e. conventional, way of expressing a given message (Fetzer, 2003). The most useful function of communicative strategies is in instructing the speakers of a given community about how to avoid a threat to their interlocutors' *Face*, especially when communicating a potentially offensive message. Face, as it is defined by Goffman (1959) and Brown and Levinson (1987), is a person's perception of self; it is a self-image which represents that person's needs and wants and which requires to be constantly maintained and respected by others during social interactions. In the linguistic theories of politeness, Face is a notion which plays a central role in the success of linguistic communication. In the context of some potentially offensive messages which typically involve speakers' requests for goods or information, or are rejections of the hearers' offers or actions, the way in which speakers tend to avoid threatening the hearers' Face is by varying the level of indirectness of their linguistic acts.

Just like speakers in normal conversations, teachers use strategies to communicate messages. Some of those messages may consist in information, other may request answers from the students. However the most threatening of all are those messages expressed by teachers which address students' errors. As was said before, teachers' main obligation vis à vis their students is to promote their cognitive progress. Such progress is achieved best by having the student to recognise that he made an error and by having him find the correct solution independently of the teacher (Chi *et al.*, 2001). This means that teachers tend to avoid giving the answers away to the students. Furthermore, cognitive progress is said to be facilitated by avoiding any form of demotivation (e.g., Lepper *et al.* (1993)). This means that teachers tend to avoid criticising the students in a *point blank* manner. Given these observations, in situations in which teachers need to correct their students, the corrective responses that they produce tend to be characterised by varying degrees of indirectness (Fox, 1991).

The purpose of the research and of the model presented in the current thesis is to capture the ways and the exact conditions under which a teachers' corrective response can vary in terms of indirectness based on (a) the educational objective of giving as much freedom of initiative to the student as possible (autonomy), and (b) the socio-psychological, motivational objective of avoiding threat to student's Face while correcting him (approval). Pertinent to this model is the notion of linguistic variation and the theory of linguistic politeness which explains some of the most important conditions under which such variation occurs.

1.1 Linguistic Politeness

Generally, natural language is characterised by an enormous linguistic variation (e.g. Halliday (1994); Brown and Levinson (1987); Fetzer (2003)). Linguistic variation means that the same main message of a linguistic act can be expressed by a multitude of different syntactic forms. Such variation is not a random phenomenon, but is determined by a number of well defined contextual factors. These factors encapsulate the socio-cultural conventions of a speech community in which a given language is produced. The conventions are manifested in specific *communicative strategies* that people in a speech community ought to use when attempting to produce a socially and culturally acceptable, i.e. *polite*, language (Fetzer, 2003). Given the assumption that all participants in a linguistic exchange are rational creatures, such observance of conventions is expected of them and is said to guarantee, in most cases, the willingness of the participants to co-operate and to accommodate each others' needs (Grice (1989); Brown and Levinson (1987)). In that sense, linguistic politeness constitutes one of the primary pre-requisites of successful linguistic communication (Leech, 1980).

Producing polite language may not always be a trivial task: what may seem polite and acceptable to one person, may be offensive and threatening to another. The ability to assess the situation with respect to a hearer's social, cultural or emotional needs constitutes a crucial facet of a speaker's social and linguistic competence.

Varying levels of linguistic politeness lead to the varying levels of *indirectness* in the language produced (Brown and Levinson, 1987), thus being one of the main direct causes of linguistic variation. The most common occurrences of indirect use of language are found in situations in which a speaker either needs to criticise the hearer, or when he may have to reject a hearer's previous act (Fetzer, 2003). It is also found in situations in which a speaker requires a favour from a hearer, for example, in the form of material goods, information, or action (Brown and Levinson, 1987). Thus, in order to achieve his communicative goal of rejecting the hearer's previous action and in order to obtain the material goods or information, a speaker needs to design his language in a way that will manipulate the hearer into providing him with those goods or information, or that will make the hearer receive the rejection without taking offence. Ultimately, a speaker's language needs to be designed to account for the hearer's *face* – a notion which according to Brown and Levinson (1987) regulates all speakers' linguistic choices at all times.

1.2 Politeness in Education

Linguistic variation as governed by certain rules of politeness and as caused by speakers varying the degrees of indirectness with which they express their communicative goals, occurs in all linguistic sub-domains including the language of education (Person *et al.*, 1995). Thanks to being relatively more constrained and hence more predictable with respect to its intentional aspects than normal conversations, the language of education, especially that produced by teachers, presents itself as good starting point for building a formal, computational model of language generation based on the theory of linguistic politeness. Indeed, this is why the focus of the current thesis is on teachers' language.

In no other social domain does the success of linguistic communication matter more than in education. Appropriate use of language specifically by teachers lies at the heart of successful cognitive and emotional development of students. Intuitively, not only does language allow transfer of knowledge from a teacher to a student, but also it allows the teacher to structure the knowledge appropriately depending on the character of the subject matter taught, the requirements of a given curriculum or chosen methodology, and, crucially, according to the individual needs of students in specific situations. In general, teachers use natural language to instruct the learner, to intervene in incorrect knowledge acquisition as well as to reinforce the correct conceptions.

Just as language used in normal conversations, teachers' language is a highly social phenomenon. It is a teachers' tool for motivating their students. Various observations of naturally occurring tutorials between human tutors and students, as well as teachers' first hand reports (e.g. Malone and Lepper (1987); Lepper *et al*. (1993); Keller (1979)) show that teachers pay at least as much, and often more, attention to the student-motivational aspects, as they do to the subject matter taught. Typically they express this attention verbally. In turn, the positive social and emotional experiences contribute to students' cognitive development – a point made most prominently by Vygotsky (1978) and Piaget (1985) who also made an explicit link between socio-emotional states of learners, their cognitive progress and natural language as a medium for expressing such states and for manifesting such progress.

Yet, no other social context presents more opportunities for one participant's, namely the teacher's, criticism and rejection of another participant's, namely the student's, actions[1] than the educational context. Indeed, it is a teacher's obligation to address their students' mistakes and misconceptions as it is the only way to promote students' successful learning. On the one hand, given the importance of motivating and encouraging the student in his learning, and on the other hand – the importance of addressing the problematic aspects of a student's progress, it seems that a teacher's task is to negotiate skillfully between the necessity to approve of the student and to provide him with the appropriate corrective feedback which will guide him out of his misconceptions and,

[1]Throughout the thesis the term *student action* is used to refer either to a student's linguistic, verbal response to a teacher's question or instruction, or to a non verbal action also made in response to a teacher's question or instruction.

eventually, lead him to a successful knowledge acquisition. As Person *et al.* (1995) pointed out, this negotiation is observable in the large variety of forms produced by teachers in situations in which they need to correct their students and which are most prominently the result of teachers varying the levels of indirectness with which they communicate the rejections of students actions. Clearly, the notion of linguistic politeness is at the heart of a teacher's skillful use of language. But how can this notion be used to inform a design and implementation of a model of teachers' selecting corrective responses?

1.3 Linguistic Politeness and Human-Computer Interactions

Several theoretical approaches to detecting and analysing linguistic politeness have been proposed, the most relevant of which are reviewed in the following chapter. The approach which is the most formalised one to date is that by Brown and Levinson (1987) and it is the one used as the basis for the model developed in the current dissertation. Recently, this approach has been used as the basis for developing several computer applications in the areas of embodied agents, e.g., (Cassell and Bickmore, 2002) and in the area of speech generation (Walker *et al.*, 1997). Unfortunately, there seems to be no precedence within the field of Artificial Intelligence in Education that could be used as a guide to such a design. To illustrate the extent of the problem, consider that the designers of Intelligent Tutoring Systems (ITSs), only recently began to recognise the possibility of modelling student-motivational aspects of tutorials and to propose ways of recognising student-motivational states during computer-mediated tutorial interactions (de Vicente, 2003). And only recently did the notion of politeness enter the realm of possible application rather than just theoretical exploration in the context of instructional systems (Johnson *et al.* (2003), and personal communication with Lewis Johnson and his group at the Center for Advanced Research in Technology for Education, University of Southern California). Although encouraging, this is a long way from ITSs which are capable of producing polite language shaped to the requirements of a given situation and to the needs of individual users.

The theories of politeness, specifically that of Brown and Levinson (1987), and the applications to computer-based natural language generation which rely entirely on those theories are very useful in demonstrating that the notion of politeness is important in improving human-computer interactions and can be formalised with real applications following from such formalisations. However, the applications, just as the theory, cannot be easily and fully reused in the context of education. This is because teachers' language produced in lesson or tutorial circumstances differs in many respects from the language produced by speakers in normal conversations. For example, when a question is asked in normal conversations, the conventional interpretation of the communicative purpose of it is that it seeks information, and that the speaker who produces it genuinely does not know the answer to it. On the other hand, in educational circumstances there may be many different functions performed by a question asked by a teacher. Generally, it is an accepted fact that when a teacher asks a student a question, she already knows the answer to it; the function of such a question is not to seek information, but to test the student with respect to some piece of knowledge which is already known to the teacher. Furthermore, teachers may ask questions to provide *hints* to the students with respect to the knowledge sought and with respect to the teachers' assessment of the correctness of the students' previous action. In short, the existing theories of politeness do not account fully for the linguistic phenomena occurring in educational contexts. In normal conversations these phenomena would be regarded as violating the Cooperative Principle (Grice, 1989) assumed to be the basis for all successful linguistic exchanges amongst rational humans, and which Principle is at the heart of the theories of linguistic politeness.

The question regarding the full applicability of the existing linguistic theories of politeness arises also in the context of human-computer interaction. Researchers such as Reeves and Nass (1998) question the nature of such interactions, specifically whether or not they follow the same patterns and are governed by the same social rules and conventions as the interactions between humans. They propose a *Media Equation* which suggests that humans interacting with computers find it difficult to divorce themselves from treating programs as different from human agents. Often they will describe such programs in terms of personality traits such as aggressive, assertive, shy or timid. Observations made by Cassell and Bickmore (2002) also suggest that people on the whole forget that they may interact with an automated agent rather than with a real person. Still as Nass and Reeves point out, the rules of politeness, while obviously playing a role in human-computer interactions, may be different from those which are in operation between humans. Specifically, their research suggests that humans interacting with computers may expect the computers to abide by the rules of human-human interactions (i.e., they may expect the computers, as they would expect the humans, to respond in appropriately polite ways) while at the same time they themselves may employ a more frank mode of communication than they would with human interlocutors. The assumption adopted in this thesis is that in order to mimic human teachers' successful communication with their students, a computer agent ought to be equipped with at least some capabilities which are characteristic of human behaviour such as recognising the needs and wants of the user, but perhaps not imposing its own needs and wants in the same way as a human would. The exact nature of the human-like capabilities and the extent to which they are required by such a computer agent to facilitate successful communication and learning still constitutes an open question in the field of Artificial Intelligence. Finding the answer to this open question is beyond the scope of the current investigation.

1.4 The Main Contributions of the Thesis

Just as this research draws from a number of different disciplines, it also contributes to more than one research area. In particular, given that the main basis for the model developed here draws upon the linguistic research in politeness, the redefinitions of certain aspects of the existing theories that were required by the social and the linguistic domain of education may be viewed by theoretical linguists as useful and valid extensions to the more general, language universal interpretations of essentially the same kinds of socio-linguistic phenomena. Given that the focus of the current thesis is on modelling the process of selecting corrective responses by teachers, the research presented here is intended to be of value to the designers of Intelligent Tutoring Systems which aim at making use of the educational and psychological power of natural language in teaching. Finally, the current research is intended to be of use to the designers of situationally determined, user adaptive natural language systems, who may find it to be a good example of using situational context and the notion of politeness as a way of modelling linguistic variation and as a systematic way of selecting amongst the linguistic choices available to speakers. The current thesis contributes to the existing relevant research in five ways:

1. From the analysis of two sets of educational dialogues, the indirectness with which teachers express their corrective messages is proposed to be the result of teachers varying the degrees of content and illocutionary specificity. While both content specificity and illocutionary specificity have been discussed in the relevant literature – illocutionary specificity being essentially equated with linguistic indirectness (e.g., Grice (1989); Searle (1969)), and content specificity being mentioned as a phenomenon specific to teachers' language, but not linked explicitly to indirectness (Graesser and Person, 1994) – no existing account of linguistic indirectness seems to define it in terms of the combination of the two types of specificity.

2. Following several theoretical proposals in which the context of a situation was identified as an essential part of any socially acceptable linguistic interaction, a set of situational factors relevant to the educational circumstances in which students' need to be corrected is proposed. Although, most of the factors proposed are based on the available research in education and educational psychology, it seems that this is the first time that such factors have been put together for the purpose of being used in the process of determining linguistic responses to students erroneous actions.

3. Following Person *et al.* (1995) observation that teachers' language manifests socially polite behaviour in ways which are similar to normal conversations, linguistic politeness was identified to lie at the heart of the linguistic variation

occurring in teachers' corrective responses. However, given the observation that teachers' language does not seem to be governed by exactly the same rules of politeness as the language produced in normal conversations, the notion of politeness with its central notion of face is redefined to suit the requirements of the educational circumstances. Although in the previous research linguistic politeness has been associated with the language produced by teachers, teachers' language has been viewed as behaving identically to the language of everyday conversations. There seems to be no precedent in the relevant literature of the theory being shaped for the purposes of generating teachers' corrective responses – an application requiring some fundamental redefinitions of the notions involved. The provision of such redefinitions constitutes one of the main contributions of the research presented here.

4. In order to model teachers' response selection based on situational context, an exploratory study is designed and carried out to test the interaction between the individual situational factors and the perception of those factors in concrete situations in terms of their importance to the linguistic decisions of experienced teachers. There seems to be no precedent in the research to date of such a study being ever carried out. The results of the study prove crucially informative to the design of the situational part of the model and to its implementation.

5. Finally, the main contribution of the thesis is the design and the implementation of a prototypical model of teachers' corrective response selection. The implementation allows one to evaluate the performance of the model in the face of the performance of human teachers in the same circumstances. Although the formal approach proposed by Brown and Levinson (1987) has been used to design a speech generation system that demonstrated the potential of applying the theory of linguistic politeness to natural language generation systems (Walker *et al.*, 1997), the novelty of the current approach is (a) that it relies on specific situational and user-related information as opposed to general social variables which are essentially black-boxes for such contextual information, and (b) that it is applied to the domain of computer-based teaching in which it constitutes the first model of this kind.

1.5 The structure of the Thesis

The rest of the thesis consists in eight chapters of which the content is summarised below.

Chapter 2 presents the review of the relevant literature. It discusses the existing approaches to the various parts of the research presented throughout the thesis and to the model developed.

Chapter 3 consists in a detailed analysis of two sets of educational dialogues with respect to the corrective responses produced by teachers to students' erroneous actions. It identifies both content and illocutionary specificity as the factors contributing to the overall indirectness of teachers' corrective responses and presents a taxonomy of teachers' corrective responses. It also leads to an observation that speech act categories are of non-discrete nature which observation is crucial to the design of the model presented in this thesis.

Chapter 4 justifies and presents the definitions of three pre-requisites necessary for designing a model of teachers selecting corrective responses, namely it defines the notion of situational context, the notion of *face* and the notion of communicative strategy as a way of addressing face in educational circumstances in which teachers need to correct their students.

Chapter 5 presents the design and statistical analysis of the exploratory study in which the relationships between different situational factors are investigated.

Chapter 6 constitutes the core of the thesis in that it presents the entire model of corrective response selection by teachers. It defines the way in which situational factors are grouped and the way in which they contribute to the assessment of different aspects of a student's face in a given situation. The chapter presents a detailed taxonomy of communicative strategies which are used to refer to and to classify different surface forms found in the dialogues studied. A method for mapping between the situational context and individual surface forms is proposed.

Chapter 7 presents the implementation of the model in terms of Bayesian Networks and in terms of Case-Based Reasoning AI techniques.

Chapter 8 presents an evaluation of the model. It presents both the formative evaluation of the system embodying the model and the summative evaluation in the form of a study in which experienced tutors were asked to rate the appropriateness of the system's preferred responses against human responses produced in identical situations. The study also evaluated the appropriateness of the system's less preferred responses against human and the system's preferred choices in identical situations.

Chapter 9 presents a discussion of the issues explored in the current thesis, it presents the author's conclusions regarding the contributions and the limitations of the model and it discusses the possible future work that can be pursued in relation to the work presented in this thesis.

Chapter 2

The Relevant Research

2.1 Introduction

The research presented in this thesis draws from several relevant disciplines, in particular from socio-linguistics, from research in education, in educational psychology and Artificial Intelligence in Education, and from research in natural language generation. Because the current thesis explores the socio-cultural aspects of language use which are both well established theoretically and which, at the same time, are relatively new to modelling natural language computationally, there is paradoxically both a lot and very little to inform the design and implementation of a model of teachers selecting corrective responses. On the general, theoretical level there is an abundance of linguistic and educational research relevant to the current work. Also there are relevant, empirically-based accounts of linguistic phenomena similar to the ones explored in this thesis, specifically in the field of education and educational psychology. Unfortunately, on the practical, application level, especially in relation to education, there is virtually no immediately relevant research available on which the current model could rely.

The purpose of this chapter is to present the pre-existing research which motivates and, to an extent, also validates the model of teachers' corrective response selection. It is also to highlight the novelty of some of this thesis' contributions in the light of existing research. The relevant research splits into three main categories:

1. The research in theoretical linguistics which points to the importance of socio-cultural aspects of human-human linguistic interactions, especially the importance of linguistic politeness and of situational context in language analysis.
2. The research in education and educational psychology which sets precedents for the analysis of the structure of educational dialogues and which catalogues the various types of teachers' feedback for the purpose of identifying the different, most effective, teaching methodologies used by teachers.
3. The research on Natural Language Generation which is generally concerned with what form of language to choose and that which is concerned with modelling speakers' linguistic choices specifically in the context of linguistic politeness.

The literature in the three categories is discussed separately and its relevance to the research presented in this thesis is outlined. Whenever appropriate the links between the categories are also discussed.

2.2 Situational Context and Linguistic Politeness

The basic interpretation of language adopted in the current thesis is that it is a form of social activity. This interpretation follows the accounts by many prominent anthropologists, linguists and philosophers of language whose views can be condensed to the following three statements expressing essentially the same idea, with the third one somewhat elaborating on the first two:

1. Language does not define "things", but it constitutes means to make things happen (Malinowski, 1923).
2. Producing and understanding language is a form of action (Wittgenstein (1958); Austin (1962); Grice (1989); Searle (1969)).

3. Language is a form of joint activity between people (Clark (1992); Clark (1996); Gibbs (1999); Suchman (1987); Garfinkel (1967), Heritage (1984), Schegloff (1972); Schegloff (1981)).

The main idea behind these three statements is that people use language to achieve certain goals, be it obtaining material goods, information, services or other things desired or expected by them. Thus, by using language people attempt to satisfy their individual objectives. However, because the achievement of those objectives often depends on others, language does not only constitute a medium for communicating one's wants and needs, but, as is the case with other joint activities, it is also a tool for coordinating one's wants and needs with the wants and needs of others (Clark, 1996). Indeed such coordination, i.e., the ability to accommodate the requirements of one's social environment is part of a person's social and linguistic competence (Fraser, 1990). According to many linguists such as Halliday (1994); Brown and Levinson (1987); Pomerantz (1984); Fox (1993); Fetzer (2003), it is this necessity and ability of speakers to accommodate the requirements of others in pursuit of their own communicative goals that causes language to be characterised by an enormous and theoretically infinite linguistic variation. From the point of view of accounting for linguistic variation in a systematic, principled way, modelling this type of speakers' competence presents one of the greatest challenges to both theoretical and computational linguists.

The interpretation of language as a social activity is crucial to the current thesis because it points to two aspects of linguistic communication which, according to many researchers, are essential to modelling language and linguistic variation in particular. First it points at the importance of situational context for language use (e.g., Malinowski (1923), Austin (1962), Heritage (1984), Pomerantz (1984), Goodwin and Duranti (1992)) and especially at the effects of changes in situational context on linguistic variation (Spencer-Oatey (1992); Goldsmith and MacGeorge (2000); Fetzer (2003)). Second, viewing language as a social activity brings to light the role of politeness in linguistic interaction – a socio-linguistic phenomenon regarded by many as a source of linguistic diversity across and within different cultures and languages (e.g., Leech (1980); Brown and Levinson (1987); Fraser (1990); Kasper (1990) amongst many others).

The rest of this section is organised as follows. Subsection 2.2.1 reviews the most relevant contributions in the domain of linguistics and with respect to the notion of explaining linguistic variation by means of analysing linguistic politeness. In 2.2.2 reviews the most prominent theories of linguistic politeness and explains the different ways in which they may contribute to the research presented in this thesis. Section 2.2.3 introduces the idea of language as a situated activity and discusses the notion of situational context in the face of the relevant research and in relation to politeness.

2.2.1 Explaining linguistic variation: the notion of politeness

Many accounts of linguistic variation in general (Searle (1969); Leech (1980); Goffman (1959) Brown and Levinson (1987)), and especially in the context of the illocutionary acts of rejecting (Fetzer, 2003), propose that the variation is due to speakers observing certain rules of *polite* behaviour, which rules encapsulate the socio-cultural demands and conventions of a given speech community. In particular, researchers observed that linguistic variation is most prominently manifested in the variation in the levels of indirectness of the linguistic signals through which the same illocution may be expressed (Leech (1980); Brown and Levinson (1987); Fetzer (2003)).

The rules of politeness which are developed, used and maintained by a particular speech community are encapsulated in the *communicative strategies* of that community. The strategies constitute the conventionalised modes of communication. Based on particular types of socio-cultural contextual parameters coupled with a community's norms of behaviour, the communicative strategies "[...] instruct the members of that community whether a specific message requires higher or lower degree of explicitness" (Fetzer, 2003, p.148). Thus the communicative strategies which define the modes of acceptable linguistic behaviour in a given community direct the speakers in the communicatively most successful ways in which their messages should be encoded by linguistic signals, and the hearers – in the ways these signals ought to be decoded.

There exists a large body of linguistic research which is concerned with linguistic politeness. From the point of view of modelling linguistic behaviour computationally, without a doubt the most attractive approach is that of Brown and Levinson (1987). This is also the approach which provides the basis for the model developed in the current thesis. Because it is the most formally tight theory of linguistic politeness available to date, Brown and Levinson's approach tends to be adopted by computationalists as the only applicable approach, and an approach which is relatively fault-free. Yet, although much less formal, other approaches to linguistic politeness provide useful insights to the cross-cultural aspects of language use and should not be ignored. Furthermore many researchers, including Brown and Levinson themselves, point at the potential problems with their proposal, warning against taking it as a definitive theory. Thus, when using their theory as a basis for building a computational model of language use, it is important to at least be aware of its potential pitfalls. While in the current thesis Brown and Levinson's theory is also regarded to be the most suitable, comprehensive and computationally possible approach, the following review of research on linguistic politeness highlights some of the problematic aspects of their theory, thereby also motivating to an extent certain assumptions and theoretical simplifications made in the thesis for the purpose of building the current prototypical model.

2.2.2 Theories of linguistic politeness

Several differing theories of linguistic politeness have been proposed to date. Thomas (1995) groups them into four categories, which she refers to as the *conversational-maxim* view (Leech, 1980), the *conversational-contract* view (Fraser, 1990), the *face-management* view (Brown and Levinson, 1987), which is also adopted in the current thesis, and the *pragmatic scales* view (Spencer-Oatey, 1992).

2.2.2.1 The conversational-maxim view

The conversational-maxim view advocated by Leech (1980) is his explanation for the deviations found in everyday language from Grice's Cooperative Principle. It is Leech's way of "remedying" the problematic aspects of the Principle, which falls short as a satisfactory account of linguistic indirectness. Leech proposes a Politeness Principle which dictates that a speaker ought to minimise (all things being equal) the expression of impolite beliefs, while maximising (all things being equal) the expression of polite beliefs.

Just as Grice defined the Cooperative Principle in terms of Conversational Maxims of Quality, Quantity, Relation and Manner, Leech defines the Politeness Principle in terms of Politeness Maxims such as Tact (minimise the expression of beliefs which imply cost to other; maximise the expression of beliefs which imply benefit to other), Generosity (minimise the benefit to self; maximise the expression of cost to self), Approbation (minimise the expression of beliefs which express dispraise of other; maximise the expression of beliefs which express approval of other), Modesty (minimise the expression of praise of self; maximise the expression of dispraise of self), Agreement (minimise the expression of disagreement between self and other; maximise the expression of agreement between self and other), and Sympathy (minimise antipathy between self and other; maximise sympathy between self and other). Furthermore a number of sub-maxims are associated with the six main ones.

In principle Leech's theory pinpoints many important aspects of linguistically polite behaviour. In particular it is the approach which points most strongly at the connection between politeness and indirectness in language, which is of particular relevance to the current thesis. However, as other researchers (Fraser (1990); Brown and Levinson (1987); Spencer-Oatey (1992); Thomas (1995)) pointed out, the politeness maxims are problematic in that they represent an open-ended list, with other potentially applicable maxims being able to join this list without any restrictions. As Spencer-Oatey (1992) states, paradoxically, this open-ended nature also constitutes the theoretical appeal of Leech's approach as it is the most cross-culturally flexible one. From the perspective of the current thesis of which the aim is to build a formal model of teachers selecting corrective responses, Leech's theory is not sufficiently principled and does not offer itself as an approach which can be easily formalised. Nevertheless, Leech's emphasis on linguistic indirectness being at the root of linguistic variation and his claim that a Principle of Politeness ought to constitute an essential part of any comprehensive model of language in general, is in line with the general approach to language analysis adopted in the current thesis.

2.2.2.2 The conversational-contract view

Similarly Fraser's (1990) much later approach which he calls the conversational contract view does not present itself as an approach which can be easily operationalised. The main idea behind this view of linguistic politeness is that politeness is an expected facet of any given interaction between participants each of whom bring their respective rights and obligations into the interaction. These rights and obligations are subject to renegotiation and change during an interaction. In this view polite behaviour is viewed as a convention, while impolite behaviour – as a violation of conventional behaviour. Although Fraser's approach is in some respects intuitively quite appealing - especially the idea that people "[..] enter into a conversation and continue within a conversation with the (usually tacit) understanding of [their] current conversational contract (CC) at every turn." (Fraser, 1990, p.233), his framework is too vague to provide a solid basis for the formal model developed here. There are two main problems which emerge during a consideration of Fraser's approach as such a basis. First, Fraser fails to make it clear the way in which the renegotiation of rights and obligations may occur; he does not specify any principled way in which such renegotiation may be explained and modelled. Second, he does not provide any clues as to the connection between the given rights and obligations of participants and the actual language produced. Given such lack of a concrete explanation as to how the conversational contract operates, it is difficult to disagree with Thomas' claim (Thomas, 1995) that his approach is rather sketchy in comparison with that of Leech or Brown and Levinson for instance. Nevertheless, his conversational contract reflects the general interpretation adopted in the current thesis of the nature of socio-linguistic exchanges.

2.2.2.3 The face-management view

Contrary to the conversational-maxim and the conversational-contract views, the face-management view advocated most prominently by Goffman (1959) and Brown and Levinson (1987), is the most detailed and the most formal approach to explaining linguistic politeness and its role in influencing the form of language produced. This is also the primary reason why this approach constitutes the basis for the model developed in the current dissertation.

The face-management view which is based on the basic idea of *face*, was first proposed in the context of linguistic politeness by Goffman (1959) who described it as something that is "emotionally invested, [and which] can be lost, maintained, enhanced and must be constantly attended to in interaction" (Goffman, 1967, p.61). Face and the regard (or disregard) that the participants in a conversation may have for it is taken as a determining factor in the speakers' linguistic decisions. Building on Goffman's interpretation of linguistic politeness, Brown and Levinson define face as a person's public self-image which is driven primarily by his *need* for

- Autonomy, i.e. freedom of action and freedom from imposition by others– *Negative Face*
- Approval, i.e. a positive self-image that is appreciated and approved of by others– *Positive Face*.

In their explanation of linguistic politeness based on face, Brown and Levinson rely on the assumption that most people have the capability for rational reasoning. The rationality assumption derives from Grice's work on *Conversational Implicature* (Grice, 1989), and it refers to this capability as *"[...] a precisely definable mode of reasoning from ends to the means that will achieve those ends*." (Brown and Levinson, 1987, p.58). This assumption is crucial to Brown and Levinson's entire approach, especially to the strategic linguistic choices that speakers are thought to make when addressing hearers in various socially and psychologically conditioned situations. The assumption is crucial, because it expresses the idea that participants in any given situation are capable of reasoning about each others' wants and needs in relation to the situations in which they find themselves. In turn this means that participants equipped with such an ability are in a position to *cooperate* with one another in the quest for achieving whatever communicative and face-oriented goals they happen to have. Consequently, this gives Brown and Levinson a solid basis for deriving *"[...] linguistic strategies as means satisfying communicative and face-oriented ends, in a strictly formal system of rational 'practical reasoning' "* (Brown and Levinson, 1987, p.58).

Generally it is in interactants' interest to *maintain* each other's Face, by acting in a non-undermining, and non-threatening manner towards each other. Such positive behaviour, arising as a consequence of their capabilities for rational reasoning, serves the purpose of maintaining cooperation and thus communication between them.

According to Brown and Levinson's theory some actions are intrinsically threatening with respect to the interactants' *wants* and *needs*. In fact, threatening actions are so common that there are theorists who claim that *every* action carries a degree of *Face Threat* to persons involved in an interaction. Dascal (1977, p.315) refers to this phenomenon as *conversational demand* which is activated the moment a person begins to speak – by so doing she automatically affects other persons' private space.

While the implication of Brown and Levinson's proposal is that only some actions are threatening, it nevertheless leads them to view linguistic acts in terms of the degree to which they are *Face Threatening*, and in terms of the *strategies* for performing *Face Threatening Actions* (henceforth FTAs).

Brown and Levinson propose five high-level communicative strategies for doing an FTA, which are shown in table 2.1. The choice of a given strategy leads to a particular set of linguistic realisations. Brown and Levinson's general rule of thumb is that the higher-numbered strategies are chosen in cases where a speaker (S) considers her intended actions to be quite threatening to hearer's (H's) Face, and when she wants to be able to opt out of ever having any harmful intentions. Thus the higher the number of a strategy, the more threatening S's intents and the more ambiguous and indirect the surface realisations of those intents are (Example 4, in table 2.1), and *vice versa*: the lower the number the less threatening the intents of S are and the less ambiguous their

Table 2.1: Five basic strategies of Brown and Levinson

Strategy Name	**Example Surface Form**
1. Do the FTA on-record, without redressive action (or baldly)	To a perfect stranger on the street: Give me some money!
2. Do the FTA on-record, with redressive action aimed at Negative Face, by using the positive politeness strategy	To a friend: Look, I know that you're broke right now, but I still need you to give me some money.
3.Do the FTA on-record, with redressive action aimed at Negative Face by using a negative politeness strategy	To a stranger at a railway station: I'm terribly sorry, sir, but I am short of 10 pence for my ticket, could you spare me some money?
4.Do the FTA off-record	To a lunch partner: Damn! I forgot my money at home.
5. Don't do the FTA at all.	Don't take any action

surface realisations (in the table – Example 1).

Except for Brown and Levinson's fifth strategy, which effectively requires one to do nothing, each of their strategies is a super-strategy which leads to up to three, increasingly lower levels of strategic, multiple choices, before the linguistic realisations level is reached. For example, the super-strategy number 4 leads to two lower level strategies: *invite conversational implicature* and *be vague*, leading to yet more, lower-level strategies which are essentially violations of one or more of Grice's four Conversational Maxims of quantity (do not say more or less than is required), quality (do not say things that are untrue), relevance (do not say things that are extraneous) and manner (avoid obscurity and ambiguity, be brief and orderly). These finally lead to choices such as: *give hints*, *presuppose*, *overstate*, *use rhetorical questions*, and to the surface level at which the prototypical syntactic and lexical structures characteristic of a given strategy are defined.

Brown and Levinson propose that the choice of a strategy is made for every situation on the basis of a calculation that sums the values for three social variables of Distance, Power and Rank of imposition. They give the following definitions of the three variables:

- *Social Distance* between speaker and hearer *D(S,H)*; a symmetric dimension of similarity or difference at which S and H stand for the purpose of a given act.
- *Power* of hearer over speaker *P(H,S)*; an asymmetric dimension of relative power, which expresses the degree to which H can impose his own plans and his own self-evaluation at the expense of S's plans and self-evaluation.
- *Rank (or degree) of imposition*, *Rx*, of an act on the Positive or Negative face of the hearer; a culturally and situationally defined ranking of imposition by the degree to which an action is considered to interfere with an agent's wants of Approval and self-determination (i.e. Autonomy).

The FTAs are defined in terms of their *weightiness* which is expressed by the function: $W_x = D(S,H) + P(H,S) + R_x$, where W_x indicates the overall, social weight of a particular situation; it expresses a number which corresponds to one of the five strategies for performing an FTA. The values for the variables are established empirically on a cultural basis for a particular cultural or social group. The weight calculated this way is used to choose an appropriate strategy for doing an FTA, and thus for choosing the optimal level of politeness and indirectness in a speaker's linguistic action.

The face-management view is very appealing in many respects. First, it is a clearly formulated theory which attempts to formalise certain aspects of speakers choosing their linguistic acts – specifically the definition of the three social variables, a way of combining them and of selecting strategies according to the calculated W_x presents itself as a very operationalisable method. Furthermore, Brown and Levinson's system of strategies and the prototypical surface realisations that they associate with each of the strategies is very useful in the context of the model developed in this thesis as it shows a systematic method for mapping between the external factors such as the social variables, the strategies that may be employed given particular values of the factors and between the surface realisations of those strategies. In that sense the approach demonstrates a significant language generative potential which is ultimately exploited in the current model.

However, although very useful and appealing, Brown and Levinson's theory also suffers from certain potential problems, which have to be addressed before their model is used to guide the design of the model of teachers selecting corrective responses. The main problematic aspect to which many researchers refer is the calculation of W_x and indeed the actual nature of the contributions of the individual social variables. As Fraser (1990) points out "asserted but untested is their claim that a W_x value of 5, for example, has the same significance for determining the strategy to be used, independent of what values of D, P, and R were summed to arrive at this value" (Fraser, 1990, p.231). Further on he asks a question which also reflects the current author's doubts as to whether Brown and Levinson's " [...] $W_x = D(S,H) + P(H,S) + R_x$ [is] a viable summary of risk, or, as it appears, [it is] much too simplistic?" (Fraser, 1990, p.235). Other researchers also pointed at the potentially too simplistic nature of the W_x calculation based on their empirical tests of the variables under different circumstances. For example, Kasper (1990) says that while some studies confirm a linear relation proposed by Brown and Levinson to exist between power and indirectness (Blum-Kulka *et al.*, 1985), and social distance and indirectness (Ervin-Tripp and Gordon, 1986) (both as cited in Kasper (1990)), other studies (e.g., Holmes (1984); Preisler (1986); Cherry (1988)) reveal that greater indirectness associated with greater politeness does not necessarily encode a lesser power of the speaker vis à vis the hearer. This means that Brown and Levinson's theory may not always predict the correct effect of the power relation between participants on the actual language produced.

Spencer-Oatey (1992) also reviews numerous empirical studies which set out to test Brown and Levinson's variables and the way in which they affect the form of the language produced. While most studies show that in the circumstances tested power consistently had an effect on the types of linguistic choices (though sometimes the effect being somewhat counter to Brown and Levinson's predictions as discussed earlier), distance between the participants of an exchange constitutes a much more complex phenomenon. Most studies concentrated on investigating the effect of the D variable in the context of requests and apologies and almost all of them point at the inadequacy of Brown and Levinson's W_x calculation with respect to this variable. First of all, only few studies (Blum-Kulka *et al.*, 1985) confirm Brown and Levinson's claims which lead to the expectation that high level of linguistic directness results from low value of D, and low level of directness – from D value being high. On the other hand, a number of studies conclude that low distance often leads to lesser linguistic directness, while high distance – to greater directness (e.g., Baxter (1984); Lim and Bowers (1991)). The complex nature of the phenomena which Brown and Levinson try to capture in the variables P and D and the potential inadequacy of their additive model is illustrated by the findings presented by Blum-Kulka *et al.* (1985) and Holtgraves and Yang (1990) in which they find an asymmetric interaction between Power and Distance. In relation to requests and apologies, both studies conclude that while in situations of equal power distance does affect strategy choice and thus, the linguistic form of the language produced ($p < 0.0001$), when the participants are not equally powerful, no such effect can be found ($p < 0.10$). On the other hand, they find that power significantly affects the choice of a strategy in the distant condition ($p < 0.0001$), but not in a close condition

($p > 0.25$)[1].

Essentially the conclusions of those studies justify Fraser's objections. Holtgraves and Yang (1990) formulate their conclusion by saying that "[...] power and distance did not combine additively [...]. This raises the question of whether an additive model is most appropriate for describing the effects of power and distance on language use." (Holtgraves and Yang, 1990, 725).

The findings of the studies discussed here are important for justifying some of the design decisions made with respect to the model presented in the current thesis. In particular in Chapter 4 it is proposed that the calculation W_x be not used to select teachers' corrective responses on the grounds that neither P nor D plays a significant role in the process of selecting such responses by real teachers. As is discussed in Chapter 4 experienced teachers who were interviewed informally by the author, tend to stress the fact that they never exercise their *de facto* higher power over student in situations in which they need to correct the students, unless a disciplinary action is required. They point out that in normal circumstances this could affect their students' motivation and could intimidate them, thus crippling their progress. This does not mean that the understanding by both teachers and students of the former's higher power is not part of the conversational contract between them. Rather in the situations in which teachers need to take corrective actions with respect to their students, they do not exploit their power over students. Thus, if one is to believe the conclusions of the studies by Blum-Kulka *et al.* (1985) and Holtgraves and Yang (1990), given the implicit understanding of the higher power of teacher over student, distance relations should not affect teachers' linguistic decisions[2]. As will be discussed in Chapter 5, this is in line with many teachers' strong objections as to the relevance of the distance condition (presented to them under the name of formality) to their decisions in student-corrective situations. A detailed discussion of both issues is presented in the respective

[1]The statistics come from the study by Holtgraves and Yang (1990) as cited in Spencer-Oatey (1992).

[2]It is important to bear in mind that no controlled study in the vein of those cited here is available with respect to the rejections which are modelled here. However, the results of the study presented in Chapter 5 are taken as a preliminary indication that not including the variables P and D in the model may be in line with teachers' behaviour in situations in which they need to correct their students and to reject their erroneous actions.

chapters 4 and 5.

2.2.2.4 The pragmatic-scales view

The pragmatic-scale view has been developed by Spencer-Oatey (1992) in reaction to the other views on linguistic politeness presented in this review, especially to the problematic aspects of Brown and Levinson's theory. In developing her approach Spencer-Oatey has been motivated primarily by the need to make the theory of linguistic politeness more cross-linguistically plausible. To that end she embraces those aspects of the previous approaches which seem to facilitate a truly cross-linguistic interpretation of language in terms of politeness, while remedying some of their problems. She proposes three sets of pragmatic scales which she believes are in operation when people in any culture make their politeness judgements:

1. Need for Consideration:	autonomy	–	imposition
2. Need to be Valued:	approbation	–	criticism
	interest/concern	–	disinterest
3. Need for Relational Identity:	inclusion	–	exclusion
	equality	–	super-ordination/ subordination

While her point regarding the existing theories of linguistic politeness being culturally biased seems valid, the aim of the model developed in the current thesis is culturally much more modest in that only the Western types of exchanges between teachers and students are the focus here. Furthermore, unlike Brown and Levinson, it is not entirely clear whether Spencer-Oatey's approach is sufficiently formal to provide a solid basis for building the model in question. Nevertheless, her approach is very appealing in the context of developing cross-culturally valid models of language production. The simplicity of her model and the inclusion of other valid and recognised theories of politeness in her framework carries a promise of being relatively easy to incorporate in the models such as the one developed here. Although Spencer-Oatey's pragmatic scales are not used in the design of the current model, her discussion of the contextual factors influencing people's judgements of linguistic politeness are very useful and are used as a guide in developing a working definition of situational context used in this dissertation.

2.2.3 Language as a situated activity: the notion of situational context

Most linguists concerned with the notion of context agree that language, in the sense that it means something to the persons that use it, does not exist in a vacuum. Instead, in the words of Wittgenstein (1958), it is a "form of life". This form of life is continuously defined by its origin, its purpose and its affect on the environment in which it occurs. Thus, one of the most prominent claims within the relevant body of research is that a linguistic act is meaningful only within a context which gives rise to it and which is ultimately changed by it. Specifically in relation to language production, Heritage (1984), for example, says that:

> A speaker's action is context-shaped in that its contribution to an on-going sequence of actions cannot be understood except by reference to the context [...]. This contextualization of utterances is a major and unavoidable procedure which hearers use to rely on to interpret conversational contributions and *it is also something which speakers pervasively attend to in the design of what they say*. ((Heritage, 1984, p.242): emphasis by the author of this thesis).

While some researchers define context rather vaguely as encompassing anything from conventions, through circumstances to intentions of speakers and hearers, other researchers use more precise terms and equate context with immediate situation. For example Voloshinov (1973, p.95) says that: "Verbal communication can never be understood and explained outside of [...] connection with *concrete situation* [...]" (emphasis by the author of this thesis), while Malinowski, who first introduced the notion of situational context into language analysis, talks of the "[...] study of any form of speech [which] would reveal [...] the dependence of the meaning of each word upon practical experience, and of the structure of each utterance upon *momentary situation* in which it is spoken." (Malinowski (1923, p.312): emphasis by the author of this thesis).

In the social tradition of linguistic analysis (Austin, 1962), an explicit link has been made between context and the linguistic (speech) acts produced by speakers. Austin (1962) proposed that language be analysed in terms of *felicity* rather than *grammaticality* conditions. Under these conditions a linguistic act ceases to be grammatical or ungrammatical, but rather it succeeds or misfires, hence resulting in either successful communication with desirable outcomes for (at least) the speaker, or at its most extreme – it results in failure of communication. For Austin, context provides an infrastructure through which an utterance gains force as a particular type of action. The felicity conditions can be treated also as classifications of context in terms of overt or tacit knowledge of participants, their attitudes, or range of participants required in given situations defined by specific social conventions.

Broadly speaking, context consists of many different levels referring to different dimensions (e.g., historical, personal, social, cultural) which affect the production and understanding of language. The different contextual dimensions interact and, in an amalgamated form, find their way to the linguistic actions ultimately produced (Givón, 1989). The essence of this type of interpretation lies in the claim by Givón and other researchers such as Halliday (1962) that context "designates the relation between the linguistic form (grammar and lexicon) and the associated *non-linguistic facts*" ((Halliday, 1962, pp.7-8): emphasis by the author), i.e. a situation. This interpretation lies at the heart of the current thesis, and ultimately at the heart of the model developed here. It also suggests that in order to define a situation one must at least identify the non-linguistic facts that are relevant to producing and interpreting language in a given domain of discourse.

Spencer-Oatey's approach to analysing linguistic politeness provides one with a relatively concrete definition of what types of non-linguistic (and in the case of Surface Behaviour category – linguistic) facts that may be relevant to speakers' linguistic choices and to people's judgements of the linguistic choices made by others. She presents those facts as "variables relating to politeness" and defines the interrelation-

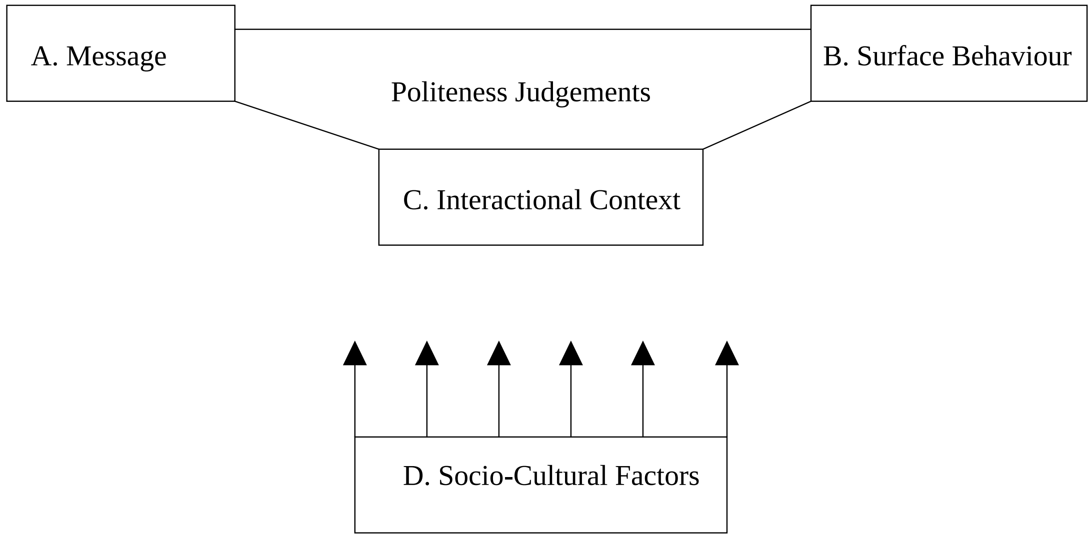


Figure 2.1: Spencer-Oatey's representation of context (Spencer-Oatey, 1992, p.13).

ship between them in the way shown in figure 2.1.

The *message* variable refers to the message that a speaker wishes or chooses to convey and which includes the current and the previous message's ideational content and illuctionary force.

The *surface behaviour* variable refers to the behaviour that can be used to convey the message including the linguistic behaviour such as the use of direct and indirect language, the semi-linguistic behaviour and the non-linguistic behaviour such as body proximity, gaze, etc.

The *interactional context* refers to the context in which the message is being conveyed and splits into five different aspects: activity type (e.g., degree of formality, constituent parts, procedural rules for participant contributions), participants' relationship (essentially aspects of interactions conveyed in Brown and Levinson's variables P and D, and Fraser's rights and obligations), participants' characteristics (e.g., age, gender, mood), number of participants (interlocutors and bystanders) and setting (not exemplified by Spencer-Oatey).

In relation to the *socio-cultural factors* Spencer-Oatey only says that they strongly influence the following politeness judgements of people:

1. The relative acceptability (in terms of the effect on interpersonal relations) of conveying a given message (A) in a given interactional context (C);
2. The relative acceptability (in terms of the effect on interpersonal relations) of conveying a given message (A) expressed in a given form (B), in a given interactional context (C).

Both of the acceptability checks listed by Spencer-Oatey correspond to the general interpretation adopted in the current thesis of the processes involved in teachers selecting the appropriate corrective responses to students' erroneous actions. Given a message which is at least to inform the student about his mistake, a teacher needs to decide on the most suitable form in which to express it based on the interactional context, which in this thesis is referred to as the *situational context*. In the model presented in Chapter 6 the main message of a teacher's corrective response (i.e., reject the student's previous action as incorrect or partially correct) is implicit to it, while modelling the judgements that teachers make with respect to the appropriate surface behaviour in the face of situational context constitutes the essence of the model.

In addition, Spencer-Oatey's taxonomy of the components of situational context is very useful and serves as a guide to defining the situational context for the purpose of the model developed here. Specifically, in Chapter 4 part of her taxonomy is used as a high level guide for identifying the contextual factors relevant to, and necessary for teachers' linguistic decisions. Her contextual categories can be instantiated with concrete situational factors relevant to the educational situations in which teachers need to correct their students. With respect to some situational categories proposed by Spencer-Oatey, the instantiations are relatively straight forward – specifically the activity type (a tutorial), participants' relationship (teacher is more powerful; student is subordinate to teacher; teacher has an obligation to guide the student, to maintain his confidence, interest as much as possible, etc.; student has a right to discover the knowledge as independently of a teacher's help as possible, etc.), and number of participants (in the model developed it is assumed that the exchange is on a one-to-one basis). On the other hand, there are factors such as participants' characteristics and setting that are less obvious and are more difficult to pinpoint. Although to the author's best knowledge there is no example available of similar instantiations being done either in the broad linguistic context of normal conversations, nor in the context of educational language, several sources are used in the current thesis to identify the factors which may be classified under the two categories. In Chapter 4 the factors which seem the most relevant to the educational situations in question here are identified based primarily on the educational literature, dialogue analysis presented in Chapter 3 and on the informal interviews with several experienced teachers.

2.3 Tutoring language as a social action

Based on the literature which is dedicated to the analysis of educational exchanges, there seems to be little doubt as to that language used in tutoring circumstances is as socio-culturally conditioned as the language used in normal conversations. Regardless of the research focus, researchers tend to agree as to the importance of interaction between teachers and students in facilitating the latters' learning (Chi *et al.*, 2001), and as to the importance of the socio-cultural aspects of educational interactions especially in relation to the use of polite language (Person *et al.*, 1995), and in promoting students' self-confidence and motivation (Lepper and Chabay, 1988).

On a general level, the relevant educational research can be divided into two main categories, each category corresponding to slightly different, but nevertheless related aspects of the model presented here:

1. The research which focuses on the linguistic analysis of educational exchanges with the aim to identify the general patterns and structures of such exchanges. Such research tends to seek to answer the question: *What is the structure of*

classroom and tutorial discourse?

2. The research which focuses on the analysis of educational exchanges of which the aim is to identify those aspects of tutoring which make tutoring effective, with the question sought being: *What makes tutoring effective?*

2.3.1 What is the structure of classroom and tutorial discourse?

Several accounts of the patterns found in classroom and tutorial discourse are available. The accounts of tutorial discourse are more recent and are motivated by the advent in the appreciation by numerous educationalists of the relatively greater benefits of one-to-one teaching to students' learning over classroom exchanges in which teachers typically cannot dedicate as much time and attention to the cognitive and emotional needs of individual students. The accounts of tutorial exchanges tend to be elaborations on the older accounts of classroom dialogues. Both types of analysis are very relevant to the current research in which both one-to-one tutorial dialogues and classroom dialogues are analysed with respect to teachers' individual corrective responses. With respect to the current thesis, the accounts are not strictly relevant in so far as the actual structure of the educational exchanges are concerned, but rather in so far as one element identified in both the classroom and the tutorial exchanges is concerned, namely teachers' *follow-up* responses (Sinclair and Brazil, 1982), or teachers' *feedback* (Graesser *et al.*, 1995).

2.3.1.1 Classroom discourse: Sinclair and Brazil's approach

Sinclair and Brazil's analysis of "teacher talk" (Sinclair and Brazil, 1982) constitutes one of the first systematic accounts of the linguistic patterns found in teachers' use of language and of the structure of the classroom discourse. In contrast with other approaches to analysing the language of education, Sinclair and Brazil's account is presented from the language-theoretic perspective – the two authors are not strictly educationalists; they are linguists and therefore their approach neither aims at improving teaching techniques nor at finding what makes teaching effective. Instead it is a descriptive account of language use in educational, classroom settings.

Drawing on their previous analysis of classroom discourse (Sinclair and Coulthard, 1975), Sinclair and Brazil describe all forms of discourse as consisting of three discourse elements: *acts*, *moves* and *exchanges*. In this description of the general discourse patterns "acts make up moves, and moves make up exchanges. The exchange is the primary unit of language interaction." (Sinclair and Brazil, 1982, p.48-49). On the simplest level, an exchange is characterised by the **Initiation (I) – Response (R) – Follow-up (F)** pattern. For example, a teacher may initiate an exchange by asking the question *"Who is that?"* (I), which normally is followed by a student's response (R), for example: *"John"*, followed by the teacher's follow-up response (R), for example: *"Good"* (Sinclair and Brazil, 1982, p.49). An initiation, a response and a follow-up respectively constitute moves. Together they constitute an exchange. Each move may consist in one or more acts, which in linguistics are also referred to as individual utterances.

The part of Sinclair and Brazil's analysis which is the most relevant to the current thesis is their brief discussion of follow-up moves (F-moves). According to their analysis, an F-move typically consists in a negative or a confirmatory feedback such as *"No, that's not it"* and *"Good"* respectively. Furthermore, Sinclair and Brazil propose that such feedback may be followed by a *re-initiating* move which consists in the rephrased or repeated original initiation. They stress that for a move to be considered a re-initiation it cannot be replaced "[...] by something which invites a different response [...]" (Sinclair and Brazil, 1982, p.88). For example, if a teacher makes the initiation *"Who is the President of the United States?"*, a lack of a student's response may force the teacher to prompt the student and to re-initiate the question. Sinclair and Brazil's requirement is that the re-initiation does not change in any way but in the syntactic form. This means that the same type of response should be fit for the re-initiation and for the original initiation; *"What's his name?"* is one example of a re-initiating move corresponding to the original initiation: *Who is the President of the United States?"*. The fact that F-moves can consist in re-initiations of which the types correspond exactly to the types of initiations proposed by Sinclair and Brazil, means that, essentially, F-moves can be of the same type as the I-moves (i.e., initiations). In turn, this suggests that Sinclair and Brazil's initiation types can be applied also in the analysis of teachers' corrective responses.

Sinclair and Brazil's taxonomy of initiations (shown in table 2.2) constitutes one of their most useful contributions. The usefulness of their approach to the current thesis is two-fold. On the one hand, when applied in the analysis of teachers' corrective responses, the taxonomy highlights the complexity of such responses, while demonstrating its own inability to capture some of response types produced by both tutors in tutoring circumstances and by teachers in classroom situations. The main problem with this approach is that in their analysis and classification of teachers' initiations, Sinclair and Brazil rely on the syntactic forms. This is a disadvantage because it prevents them from elaborating on their original idea that a move can be made of many acts. For example, it is not clear from their discussion whether the F-move: *"Come on now. What is his name?"* consists of one act followed by another move (the re-initiation of *"Who is the President of the United Sates?"*) or whether it consists simply of two acts. As a consequence of this, despite of the definitions provided, it is difficult to distinguish between moves and acts. Furthermore, regardless of the definitions, the building blocks of the F-moves such as the one just exemplified are discrete and are characterised by discrete syntactic forms. Such approach allows one to account for some corrective F-moves found in the dialogues studied in this thesis, but not for all of them. As is discussed in detail in Chapter 3, many F-moves found in dialogues can neither be characterised by a discrete move, act, or syntactic form.

Perhaps part of the problem with Sinclair and Brazil's approach, which prevents them from making their definitions of *move* and *act* clearer and more in tune with the linguistic data available, is their requirement on the type of re-initiation needing to be the same as that of the original initiation. This is not only very strict, but also it does not capture some of the crucial aspects of teacher talk. Again the dialogues analysed in Chapter 3 show that teachers' corrective responses may consist in re-initiations which refer to the same content, but which do not correspond in type to the original initiations.

Table 2.2: Sinclair and Brazil's classification of teachers' language (Sinclair and Brazil, 1982, p.76).

Syntactic Structure	**Initiation**	**Fit Response**	**Example**
Declarative: Informing	–	Acknowledgement	*"The Earth is round."*
Interrogative: Positive Polar	Eliciting: decision	Decision	*"Is the Earth round?"*
Interrogative: Negative Polar	Eliciting: agreement	Agreement	*Isn't the Earth round?"*
Interrogative: Tag	Eliciting: agreement	Agreement	*"The Earth is round, isn't it?"*
Interrogative: WH-word	Eliciting: content	Content	*"What shape is the Earth?"*
Imperative: Directing	–	Non-verbal	*"Draw the Earth as a circle."*

As a consequence they may also elicit different types of responses. Indeed, different, and according to Sinclair and Brazil's taxonomy, incompatible initiations may elicit the same types of responses. As an illustration of this consider again Sinclair and Brazil's initiation example: *"Who is the President of the United States?"*. The student's silence may suggest to the teacher that the student is struggling with finding the answer to the question. As a consequence of this the teacher may decide both to prompt and to hint in her F-move and thus, to re-initiate using a different type, e.g., *"He used to be a Hollywood actor, wasn' t he?"*. The re-initiation is different from the original initiation in terms of its syntax (WH-question vs. tag question) as well as in terms of the fit response (content vs. agreement). Although different in type, and eliciting a (partly) different response, the F-move is a re-initiation of the original question in that the teacher still seeks from the student the answer as to the identity of the USA president. In the interpretation adopted in this thesis, the tag question used as a re-initiation of the original question would be interpreted as eliciting more than one type of student response: an agreement (or disagreement) and the content response fit for the original initiation. Thus, this example can be also used to illustrate the potential problem with Sinclair and Brazil treating the moves as consisting always of acts which belong to discrete categories and as eliciting single and discrete types of responses. As is shown and discussed in Chapter 3, categorising speech acts in terms of discrete categories is rather simplistic and follows from the traditional approaches to speech act analysis such as that by Searle (1979). As is illustrated in the taxonomy in Chapter 3, teachers' corrective responses are characterised by a multitude of goals. While this in itself does not make those responses non-discrete in nature, the fact that the same goals may characterise different acts means that these acts cannot be classified as belonging equivocally to one category or another. Thus, if speech act categories are continuous or non-discrete in nature, it means that a single act can be both *assert* and *question*, for example, with either communicative qualities characterising that act to some degree. A further discussion of non-discrete nature of speech act categories can be found in Chapter 3, page 104. The observation that speech act categories are of non-discrete nature is in line with research in psychology and linguistics (e.g., Rosch (1977); Vanparys (1996)) which show that human categorisation happens in terms of continua and prototypes rather than in terms of absolute categories. This is a crucial observation which has an impact on the overall approach adopted here to modelling teachers' corrective responses.

While Sinclair and Brazil's taxonomy is problematic in certain respects, its simplicity means that it can be easily adapted to account for the type of data presented in Chapter 3. Most importantly the taxonomy allows one to examine teachers' individual responses from the point of view of the communicative goals that they satisfy (initiation and elicitation type) and from the point of view of perlocutionary effects that they are likely to achieve (fit response type). In Chapter 3, this aspect of the taxonomy is used to develop a classification of teachers' corrective responses in terms of such goals, which in turn also facilitates an account of those types of teachers' corrective responses which seem to initiate multiple elicitations.

2.3.1.2 Tutorial discourse: Graesser *et al.*'s approach

One of the most influential accounts of the general structure of tutorial interactions is that of Graesser *et al.* (1995). In this account, tutorial interactions are characterised in terms of the five step dialogue frame shown in table 2.3. For example, in the context of basic electricity and electronics a tutor may initiate an exchange (Step 1) by asking a question: *"What is needed to light a light bulb?"*. The student may answer (Step 2) by

Table 2.3: Graesser *et al.*'s 5-step dialogue frame (Graesser *et al.*, 1995, p.505).

Step 1:	Tutor asks question
Step 2:	Student answers question
Step 3:	Tutor gives short feedback
Step 4:	Tutor improves the quality of answer
Step 5:	Tutor assesses student's understanding

saying *"Wires"*, which may be followed by the tutor's short feedback *"OK"*, followed by a scaffolding episode (Step 4) which attempts to get the student to improve on his answer: given that also *power source* is needed to light a light bulb – a part of the answer that the student did not provide – the tutor may *hint*, she may *pump* the student for more information, or she may *complete the student's answer*, amongst other ways of eliciting knowledge from a student (Graesser *et al.*, 1995). In step 5, the tutor simply gauges the student's understanding of what has been just discussed; she may ask the question such as: *"Is this clear now?"*.

In the context of teachers' corrective responses, the most relevant aspect of the five-step frame are the steps 3 to 5. In the current thesis they are all clustered under the common label of corrective feedback. As is accounted for in the model presented in Chapter 6, these three steps may not always be present in a teacher's corrective response. Often the teacher will move on straight to step 4, apparently omitting step 3 (in the data studied in this thesis, such apparent omission is made in 23% of all corrective responses). Similarly step 5 is not always part of a teacher's corrective response and is most frequently found (95% of all occurrences) at the very end of a tutoring episode concerning a particular topic in which the tutor simply tells the answer to the question sought.

The apparent lack of step 3 in some corrective responses produced by teachers is an interesting phenomenon which has been also observed by Fox (1991) and Fox (1993).

In her data Fox found that skilled tutors may use lengthy pauses or may hesitate to signal a negative feedback. This is also in line with the observations made by researchers concerned with language use in general (e.g., Thomas (1995); Brown and Levinson (1987); Fetzer (2003)) who claim that such silent acts by the speakers may signify a considerable threat to the hearers' face (Thomas (1995); Fetzer (2003)), or may mean that the speaker assessed the risk of producing an act overtly as too great in given circumstances (Brown and Levinson, 1987). In either case, it seems that using silence to communicate a potentially offensive message constitutes part of a social convention, also in the context of educational interactions. Since the lack of overt realisations of step 3 has been observed in the two types of dialogues studied in this thesis, the communicative strategy of not performing an FTA (Brown and Levinson's strategy 5) is incorporated in the model presented in Chapter 6.

Graesser's five step dialogue frame is very useful to the current thesis in several respects. Most crucially, it provides a relatively detailed definition of step 4 which constitutes a method known in education and educational psychology as *scaffolding*. Scaffolding is a form of guidance which consists in a teacher structuring a task for the purpose of facilitating a student's progress. The structuring task may involve the decomposition of a complex task into simpler ones or addressing only part of the task (Brown and Palincsar (1989); Cole (1978); Collins *et al.* (1989); Merrill *et al.* (1992); Woods *et al.* (1976) as cited in Chi *et al.* (2001)). In essence, scaffolding is "[...] any sort of guidance that is more than a confirmatory or a negative feedback" (Chi *et al.*, 2001, p.473). In this definition of the scaffolding step, Graesser decomposes it into ten individual strategies which can be used by a teacher to realise it. The scaffolding strategies proposed by Graesser are shown in table 2.4. Because scaffolding is often found in the situations in which teachers need to correct the students, the account along with other researchers' suggestions (primarily, Chi *et al.* (2001); Person *et al.* (1995); DiPaolo *et al.* (2002); Fox (1993)) provides a solid guide in identifying the various strategies used in such situations and which strategies are presented and discussed in detail in Chapter 6. Specifically, Graesser's strategies 1, 2, 3, 4, 5, 7 and 10 seem to be reflected in the dialogues studied in this thesis. In Chapter 6 those strategies which are derived from the educational research, including Graesser's, are clearly marked

Table 2.4: Decomposition of Step 4: Tutor improves quality of answer (Graesser *et al.*, 1995, p.505).

1. The tutor splices in a complete or partial answer
2. The tutor summarises answer
3. The tutor gives hint
4. The tutor pumps the student for more information
5. The tutor traces explanation or justification
6. The tutor elaborates on answer
7. The tutor asks a question to elaborate on answer
8. The tutor presents an example
9. The tutor corrects a misconception
10. The tutor issues a command or indirect request for the student to complete an activity

whenever appropriate by means of the letter *E*.

The different ways in which a tutor may provide scaffolding represent different strategies which may be realised by different syntactic forms and which may be characterised by different degrees of indirectness. For example a correction of a student's misconception is likely to be more direct and declarative in nature than a hint which is likely to be a question which is highly underspecified with respect to the content of the answer sought. Indeed, on a very general level, it is possible to speculate about the level of content specificity expressed by each of the ten scaffolding strategies. Content specificity is observed by Graesser and Person (1994) and Graesser *et al.* (1995) to be an important issue in tutors' language. They observe that tutors often ask questions which are not sufficiently content specific for students to know how to answer them best. Such underspecification of content in tutorial circumstances seems to be the result of tutors wanting to put as much initiative in the students' hands as possible and therefore trying to avoid giving the answers away. This is true of opening questions as much as of the scaffolding strategies used to realise teachers' corrective responses. The concept of content specificity is a crucial one to the analysis of the dialogues presented in Chapter 3 and to the model described in Chapter 6. Unlike in Greasser's account, different levels of content specificity are regarded here as contributing (together with illocutionary specificity) to the overall levels of indirectness of teachers' corrective responses. Furthermore, content specificity is also crucial for the definition of student's face modelled in the current thesis. In particular, this type of specificity is currently associated with the *Autonomy* dimension which together with the *Approval* dimension defines a student's face. The definition of indirectness which relies on content specificity is given in Chapter 3, while the definition of student's face is given in Chapter 4, and is operationalised in Chapter 6.

Based on the discussion of the approaches of Sinclair and Brazil and Graesser respectively, the main difference between classroom and tutorial discourse structure lies in the number of steps involved in a teacher/tutor addressing a student's answer. This difference is the result of the assumptions made by various researchers including Graesser, that under one-to-one tutorial conditions tutors spend more time on elaborating on students' answers than teachers do under classroom conditions. Indeed one of Graesser's claims, based primarily on the reports by Mehan (1979), is that in classroom interactions steps 4 and 5 are never reached. Although, these assumptions are adopted also by other researchers (e.g., Sinclair and Brazil (1982); Lepper and Chabay (1988); Chi *et al.* (2001)) and may be supported to an extent by observations of real dialogues under the two types of circumstances, the comparison of the corrective responses made by the tutor in one-to-one dialogues with those made by teachers in the classroom conditions discussed in Chapter 3 have shown no significant differences between those responses.

In the Polish dialogues studied teachers often address the students' erroneous action in a very similar way as the tutor does in one-to-one American exchanges. It is often the case that a teacher will not involve Graesser's step 4 explicitly in addressing the one student who gave the incorrect answer, but instead she will try to improve the quality of the answer for the benefit of the entire class. Nevertheless step 4 of

Graesser's tutorial dialogue frame is present in the classroom dialogues analysed in this thesis. The observation that step 4 does occur under classroom conditions is also supported by the comments made by the teachers and tutors who took part in the two studies presented in this thesis (chapters 5 and 8 respectively), in which they pointed at the fact that under classroom conditions, in cases where one student gave an erroneous answer, they often end up having a one-to-one elaboration episode with the student. In such circumstances step 4 is definitely part of their teaching, with step 5 being often addressed to the entire class or tutorial group.

The fact that the dialogues studied in this thesis along with the teachers' and tutors' supporting comments suggest that the same interaction steps may be appropriate to describe tutorial and classroom exchanges is very important in characterising the socio-linguistic focus of this thesis. This characterisation is somewhat counter to the generally accepted split between tutorial and classroom interactions which also assumes a difference between tutors and teachers. The aim of the current thesis is to model the language produced by experienced educational professionals, be it tutors or teachers. To be classified as experienced, a tutor or a teacher must have several years of tutoring or teaching experience and must be an expert in the domain she teaches. In an ideal world, only interactions between such professionals and the students should be considered as a sensible basis for a computational model of teachers/tutors language. On the other hand, most of the accounts concerned with identifying the aspects of tutoring which makes it effective rely only on the analyses of interactions in which tutors are para-professionals (Chi *et al.*, 2001) and are very inexperienced both in the teaching methods and in the domain. This point is elaborated on further in the next section.

Research on analysing teachers' and tutors' language is very valuable to the model presented in this thesis. This is because it identifies the most typical linguistic strategies employed by teachers and because, in an informal way, it links these strategies with the contextual factors which may trigger their use. Thus, the most common contextual triggers seem to be the degree of correctness of the student's answer (for example, the form of Graesser's scaffolding strategy 1 in table 2.4 is typically determined by whether the student's answer is partially correct or completely incorrect), the difficulty of the material (example giving, breaking a large task into smaller ones, etc.) and by the student's motivation which typically determines whether the teacher will use direct or indirect approach.

2.3.2 What makes tutoring effective?

Most educational research, especially that which is done in educational psychology with the view of informing the design of Intelligent Tutoring Systems pursues the question of what makes tutoring effective. A number of important studies have been made to answer this question by looking at it from three slightly different perspectives:

1. The best-strategy perspective.
2. The affective tutoring perspective.
3. The politeness in tutoring perspective.

2.3.2.1 The best strategy perspective

According to Collins and Stevens (1991) teachers use teaching strategies to pursue their teaching goals and agendas in order to teach in a systematic, time efficient manner. Yet, as McArthur *et al.* (1990) point out in the context of intelligent tutors, teaching strategies constitute the aspect of teaching which is the least developed and understood to date. One of the reasons for this may be traced to the general lack of understanding, not so much of the kinds of strategies that teachers use, but of the kinds of conditions under which particular strategies may be used, and the kinds of effects, if any, that the use of particular strategies has on students' learning. The relevance of the research concerned with identifying the effective teaching strategies to research presented in the current thesis is not immediate in the sense that it is not the immediate purpose of the model developed here to test the effectiveness of the various corrective responses on students' learning gains. However such research provides a general, educational motivation for building a model such as the one presented here, and the different discussions of the most commonly used strategies, and the ones that are believed to be the most effective to students' learning, provide guidance in the classification of the corrective responses found in the dialogues studied here.

One of the most prominent investigations of the effectiveness of teaching strategies on students' learning gains, and an investigation which encapsulates most of the research in this area to date, is that by Chi *et al.* (2001). This research addresses a number of important questions regarding the role of teaching strategies, and indeed of a teacher/tutor, in a student's learning. In this research Chi investigates three hypotheses which characterise educational research to date: the tutor-centred hypothesis, the student-centred hypothesis and the interactive hypothesis.

Essentially the tutor-centred hypothesis is one in which the tutor is at the very core of a student's successful learning. In this approach the tutor's use of appropriate strategies is regarded as the main factor in facilitating successful learning.

The student-centred hypothesis is one in which the student's active generation is taken to be at the heart of successful learning. Active generation is explained by Chi as a student's active engagement in constructive learning, whereby the learner '[...] constructs an understanding by interpreting the new, to-be learned material in the context of prior knowledge" (Chi *et al.*, 2001, p.477). Contrary to the traditional view on teaching, this hypothesis suggests that tutor's role is not to instruct, but to support the student's initiative and to encourage him to produce substantive responses. The role of teaching strategies is still great under this hypothesis, but their nature is different from those used under tutor-centred view.

Under the interactive hypothesis the effectiveness of tutoring is the result of an interaction between the student and the tutor. This type of tutoring can be characterised in terms of the distinction between "interactive" and "non-interactive" communicative acts (Chi *et al.*, 2001, p.481). The interactive acts are those which elicit a response from a student regarding the content, his comprehension of a topic, or which constitute scaffolding acts. On the other hand, "non-interactive" acts are those with which the tutor instructs the student and gives lengthy explanations to the student without giving him the opportunity to respond.

Chi tested the three hypotheses empirically by means of two studies in which different tutoring tactics were used. For each hypothesis she compared the results of the students' pre-tests and post-tests. The results provide support for all three hypotheses, with an additional finding emphasised by Chi as to possibly undue credit being given by many researchers to the effectiveness of explanations and feedback given by the tutors: even with limited use of the two, the students' learning was just as effective as when the tutors were giving explanations and feedback.

There are two aspects of Chi's account which are relevant to the current thesis. The first aspect is her discussion related to the tutor-centred hypothesis in which she brings into focus the question of the importance of a tutor's expertise to students' learning gains. The second relevant aspect is that which discusses the benefits of using scaffolding strategies, i.e. the strategies which put most of the effort in the hands of the students.

With respect to the first aspect, Chi investigates the tacit assumption of the tutor-centred hypothesis that tutors select specific tactics and strategies in a systematic and rational way. If this is the case, she speculates, then it must be possible to observe the conditions under which a strategy is used, which strategies are optimal for what concrete situations, and whether or not a strategy is effective (Chi *et al.*, 2001, p.475). Based mainly on the studies such as that by VanLehn *et al.* (2003)[3] in which he examined the way in which two expert human tutors in the domain of physics corrected the students, at first sight, her conclusions are not encouraging to the model presented in this thesis. First, VanLehn found that there was no systematicity in the way the tutors taught the students and there seemed to be no optimum way in which to teach a content rule[4]. Second, VanLehn found that the tutors' moves were inconsistent in response to the same types of student actions. Third, he found no relationship between the use of a specific tactic and students learning gains. Chi re-examined the same data to gain a confirmation of these findings, and was drawn to make very similar conclusions.

[3]When analysed by Chi, VanLehn's studies were conducted but unpublished.

[4]A content rule can be of the form: "If a taut string is attached to an object, there is a tension force on the object exerted by the string" (Chi *et al.*, 2001, p.475).

Although not very encouraging at first sight, the results of VanLehn's and Chi's investigations are not particularly damaging to the assumptions on which the current model is built and which do include the beliefs that teachers/tutors are systematic in their choices of the strategies and that there are more or less optimal ways in which they may address a situation. In its prototypical form presented in this thesis, the model is not concerned with the strictly educational aspects of strategies use such as what to say to the student (i.e. how to teach a specific rule) and when to say it. Instead the model focuses on how to say it based on the initial assumption that by the time a tutor needs to decide on the form of her message she knows what to say and when to say it. Still, certain elements of what to say may be determined at this level. In particular, the model is designed to work out the appropriate level of content specificity (the amount of *Autonomy* to be given to the student) which may in turn affect the way in which a rule is taught. The fact that tutors' choices may be systematic after all is supported by the results of the summative evaluation of the model (Chapter 8) in which the participants (experienced tutors in the domain of electronics and electricity) agreed as to the ways in which they would address the same situations.

While, addressing the third conclusion made by Chi and VanLehn is beyond the scope of this thesis, in reaction to their second conclusion that the tutors do not employ the same strategies consistently in response to the same types of situations, one has to take into account the fact that neither Chi nor VanLehn place those types of actions in the context of more detailed situations. In other words, neither of them examined the conditions under which the different strategies were used in detail. Instead they treated the students and the situations as the same for each type of response. The hypothesis that the same types of student erroneous actions may be addressed in different ways by a tutor is in line with the model presented in this thesis. The differences in the tutor responses are assumed here to be determined by specific situational parameters such as the motivational differences between individual students, time constraints, and characteristics of the material taught.

The second relevant aspect of Chi's account is her discussion of the strategies which under the student-centred hypothesis seem to be very commonly and successfully employed. The discussion is relevant in that it provides a basis for a consistent examination and classification of the types of corrective responses according to the educational and communicative strategies employed by teachers. The majority of the general strategies used and the overall linguistic patterns identified under this hypothesis correspond to the linguistic data studied in this thesis. In particular the fact that tutors tend not to give direct negative feedback as a response to students' incorrect answers is in line with the findings of this thesis; Chi cites Evens *et al.* (1993) results which suggest that 44% of all corrective responses given by tutors in face-to-face sessions are general suggestions rather than direct corrections. This is very much in agreement with the analysis of the dialogues presented in Chapter 3 in which 46.3% of all corrective responses analysed were expressed by indirect linguistic means. Chi discusses the most common types of indirect feedback given by tutors in various studies conducted by different researchers. Essentially, she splits them into content-free prompting and scaffolding prompts, such as *requesting explanations* or *asking leading questions*. Often the indirect manner in which the tutors provide corrective feedback to the students is simply referred to as *hinting* (e.g., Fox (1991); DiPaolo *et al.* (2002)) which has been associated with increased student motivation and consequently with improved student learning (Lepper *et al.* (1993); Fox (1991); Graesser *et al.* (1995); DiPaolo *et al.* (2002)). The taxonomy of all the strategies which directly informs the model presented in this thesis is given in Chapter 6.

2.3.2.2 The affective tutoring perspective

Student motivation is a very important aspect of successful learning. As Goleman puts it "the extent to which emotional upsets can interfere with mental life is no news to teachers. Students who are anxious, angry, or depressed don't learn; people who are caught in these states do not take in information efficiently or deal with it well" (Goleman, 1996, p.78). It is not surprising then that human tutors have been found to recognise the value of motivating their students for the purpose of advancing their learning and to dedicate at least as much time and effort to achieving student motivational goals as to purely pedagogical goals (Lepper *et al.*, 1993). Furthermore, in the context of computer-based instruction Lepper and Chabay (1988) argue that the strategies which are geared to improve students' motivation are as important as those which are geared to advance students' cognitive progress. This seems to be especially true in the situations in which teachers need to correct their students. Such situations can be potentially very demotivating to the students, and teachers, especially those whose tutoring can be characterised in terms of Chi's student-centred and interactive hypotheses, will try to gear their corrective responses to avoid affecting negatively the students' participation in active construction. On the one hand, on a general level, the tutors' awareness of the potential consequences of demotivating the students can be observed in the level of hinting with which a teacher provides a student and in the level of linguistic indirectness manifested in an act used by the teacher to express a hint. On the other hand, teachers' tactics geared to avoid demotivating the students as much as possible and the fact that these tactics are most prominently manifested in their language leads back to the role of linguistic politeness in social interactions, specifically to the notion of student's face (i.e., the student's positive self-image), which when threatened may result in student demotivation. Thus, the research which falls under the affective tutoring view is extremely relevant to the research presented in the current thesis as it allows one to link the language used by teachers to educational benefits and to the wider social phenomenon of politeness.

The motivational research is also relevant in the current thesis in the context of developing the situational component of the model in that it provides the clearest account in the available educational literature of the possible conditions which need to be met in order to facilitate (or to diagnose) students' motivation and progress. For example Malone and Lepper (1987) propose a list of different factors influencing student's motivation. They propose that teachers have motivational goals such as to challenge the student, to arouse the general curiosity of the student as well as the sensory and the cognitive curiosity, to support the student's sense of self-control and to provide support for the student's fantasy. These goals are further associated with specific influences, i.e. with factors which influence the achievement of those goals. For example, they suggest that challenge depends on factors such as the level of difficulty, goals of the task, performance feedback given to the student and the student's sense of self-esteem;

sense of control depends on the range of outcomes provided by the environment as well as the probability of the student to influence the possible outcomes, etc. In Chapter 4 some of Malone and Lepper's influences are interpreted as situational parameters and are included in the situational part of the model as influencing the assessment of student's *face* along the two dimensions of *Autonomy* and *Approval*. The correct interpretation of those influences in terms of the situational parameters is also guided by the discussion found in Lepper *et al.* (1993) referred to in Chapter 4.

The support for the *Autonomy* and *Approval* dimensions which are used in the current model to characterise a student's face and consequently along which the appropriate types of responses are chosen, can be found in the taxonomy of motivational variables developed by de Vicente (2003) which follows the proposals by Keller (1979), Keller (1983), Malone and Lepper (1987) and Lepper *et al.* (1993), amongst others. de Vicente defines the motivation model variables (shown in table 2.5) for the purpose of diagnosing whether or not a student is motivated. While some of the variables are not immediately relevant to the model developed in this thesis, other ones can be linked directly to the two dimensions. Thus, control, challenge, independence and effort can all be used to define the notion of Autonomy. On the other hand, confidence and satisfaction contribute to the definition of Approval.

The definitions of situational context in terms of situational parameters and in terms of the two dimensions of face are provided in Chapter 4.

2.3.2.3 The politeness in tutoring perspective

The motivation for investigating the role and the nature of linguistic politeness in tutoring comes primarily from research on affective aspects of teaching and learning. It also comes from the observation by some educational linguists and psychologists (e.g., Sinclair and Brazil (1982); Graesser *et al.* (1995); Person *et al.* (1995)) that just as language used in normal conversations, teachers' language is characterised by a significant linguistic variation.

In her, thus far unchallenged, analysis, Person follows the proposals of many the-

Table 2.5: de Vicente's definitions of motivational model variable (de Vicente, 2003, p.46)

Variables	**Definition**
Control	The degree of control that the student likes having over the learning situation.
Challenge	The degree to which the student likes being challenged during instruction.
Independence	The degree that the student prefers to work independently.
Fantasy	The degree to which the student likes the learning materials being embedded in an imaginary context.
Relevance	The degree to which the student regards the learning materials are personally relevant to him.
Confidence	The student's belief in being able to perform the task at hand correctly.
Sensory interest	The amount of curiosity aroused through the interface presentation.
Cognitive interest	Curiosity aroused through the cognitive or epistemic characteristics of the task.
Effort	Degree to which the student actively constructs.
Satisfaction	Overall feeling of goal accomplishment.

oretical linguists such as Grice (1989); Goffman (1959); Brown and Levinson (1987), and observes that teachers' language also abides by the rules of the more general socio-cultural contexts. Just like those theorists, she observes that a given degree of indirectness employed by a teacher in an utterance is dependent on the level of politeness that the teacher deems necessary in a particular situation and with respect to a particular student. For instance, students who are not very confident may require to be informed about the problems in their answers in a more indirect way than students who are fairly self-satisfied. More interestingly, Person comments on the possible link between certain rules of politeness and the specificity of content expressed by teachers in their questions and corrective feedback. In particular, she claims that politeness as often manifested in the indirect use of language and in varying degrees of content specificity, may inhibit a tutor's ability to give adequately informative feedback to the students. Such feedback is often needed to prevent the students from floundering and thus, from getting confused and frustrated which, if not prevented, may have adverse effects on their learning.

Although encouraging with respect to the research presented in this thesis in the sense that it links the notion of linguistic politeness to tutors' language use explicitly, Person's analysis seems to suffer from two problems. The first problem is her assumption that the same rules of politeness that apply in everyday conversation also apply in teacher-student interactions – an assumption based on Resnick's observation that tutoring dialogues are more similar to normal conversations than the lecturing style typically used in classrooms (Resnick, 1977). However, Person does not validate this assumption, despite the fact that she recognises that the exact rules used by teachers in different educational circumstances may differ from those proposed by Brown and Levinson as applying to everyday conversations. The second problem, which in part explains the first one, is that Person relies on the examples of interactions between students and very inexperienced tutors whose prior training and familiarity with the subject is minimal. Thus, the inhibitions, which Person attributes to tutors observing the rules of politeness could as well be attributed to the tutors' general incompetence and lack of confidence. Such inexperienced tutors do not have an adequate training to plan their responses adequately, nor do they tend to apply any specific teaching strategies (Chi *et al.*, 2001) to guide them in the amount of information they should give to the student and as to the extent to which they should accommodate for the student's emotional and psychological needs. Furthermore, in the context of trying to model teachers' responses Person's account is too impressionistic to be implemented in a formal model directly.

Contrary to Person's analysis, the claim of the current thesis is that both the communicative strategies as expressing the rules of politeness and Face as the centerpiece of a successful social interaction, are crucial to successful teaching and learning. However, not only may the rules of politeness apply differently to educational situations, they may also differ from the ones which apply to everyday circumstances. The similarities, which Person assumes to exist, between tutoring language and the language of everyday conversation result from the teachers' language being deeply embedded in the culture of their wider speech communities. However, the tutorial circumstances, and teaching as a profession, define the boundaries of an inner community of which the culture and, thus, the conventions are different from those which govern the interactions on the outside of such community. For example, conventionally, teachers ask questions not because they do not know the answers to those questions, but because they want to test the students' knowledge. In that sense teachers' questions violate the conventions of normal conversations in which, on the whole, such "testing" questions would be regarded as manifesting unreasonable behaviour and would constitute violations of Grice's Cooperative Principle. The communicative strategies employed by teachers are therefore interpreted here as the conventionalised modes of communication which encapsulate the demands of both worlds. A detailed account of the types of strategies relevant to teachers' language is given in Chapter 6 in the form of a strategic system.

The research which focuses on determining the factors which may improve students' learning gains is very informative with respect to the contextual factors which may be relevant to tutor's response decisions. In particular, the research on student motivation and Person's analysis of tutors' language specifically in relation to politeness provides the clearest account yet of the possible correspondences between the responses and the contextual triggers. Here again, the difficulty of the material and the student's overall motivation as defined in terms of his confidence and interest are the factors most commonly referred to. Although Person's analysis cannot be used directly in the current model for the reasons explained earlier, it does constitute an important and very relevant work to the current thesis. In particular it is very valuable in highlighting the relationship between social conventions such as manifested through politeness and the language produced by tutors in educational settings and in situations in which the tutors have to react to students' misconceptions.

2.4 Approaches to Natural Language Generation

Just as is the case in the approach presented in this thesis, the decisions involved in selecting an appropriate linguistic form in which to express a given message lie at the heart of the research in Natural Language Generation (NLG). However, it is only very recently that the types of linguistic phenomena such as linguistic politeness, which are central to this thesis entered the realm of real NLG applications. In sub-section 2.4.1 the most common approaches to NLG are discussed and the main reasons for them not being used in the current approach are given. Subsection 2.4.2 describes two NLG applications which make use specifically of the theories of linguistic politeness in modelling linguistic variation and their limitations are discussed in the context of the limitations of the theories on which they rely.

2.4.1 An overview of the relevant approaches to NLG

The two most prominent approaches to NLG include: the *Schema-Based approach* (McKeown, 1985), and the *Intentions-Based approaches.* The intentions-based approaches can be divided roughly into further two types: *planning-driven* language generation (e.g., Cohen and Perrault (1979); Perrault and Allen (1980); Appelt (1985); Cohen and Levesque (1990); Moore and Paris (1993)) and *function-driven* generation (e.g., Mann (1983); Bateman (1997)) the latter being based on *Systemic Functional*

Grammar Theory (Halliday (1978); Halliday (1985)). Except in the case of McKeown's approach, it is not the intention in the current discussion to reject any of those approaches as generally unsuitable for modelling linguistic variation based on politeness. Instead, the argument followed here is that on a specific level and for a number of reasons, it would seem premature to use these approaches for the prototypical model presented in this thesis. These approaches are briefly reviewed and the reasons spelled out.

2.4.1.1 Schema-Based Approach

One of the earlier and highly influential approaches to NLG is that proposed by McKeown (1985) in which language is generated based on schemata which essentially represent stereotypical structures characteristic of a particular type of discourse. For example, when defining an object, particular linguistic patterns can be observed that are characteristic of the process of giving a definition such as naming the class and the attributive function of the object as expressed by the sentence *"A ship is a water-going vehicle that travels on the surface"*, by providing an analogy, naming the object's attributes or renaming it, for example: *"Its surface-going capabilities are provided by the DB attributes displacement and draft"*. McKeown's schemata rely on rhetorical predicates which refer to speakers' means for achieving their goals. They also demarcate the structural relations in a text. In some sense then schemata seem related to the linguistic strategies which occupy a central place in the linguistic theories of politeness. The schemata are essentially templates of connected text with the aspects of the domain knowledge typically being represented by variables to be replaced appropriately by concrete referents depending on a domain knowledge .

Although McKeown's schemata capture the interpretation of language followed in the current thesis, namely that appropriate use of language (in her case the way in which particular predicates can be combined) depends on particular cultural and linguistic conventions, her approach is not applicable for one fundamental reason: the schemas do not seem to refer to the speakers' intentions which are crucial to the current approach. Without including speakers' intentions or other contextual information into a model of language production explicitly, it is difficult to see how the appropriate linguistic choices can be made and how truly varied the linguistic output produced can be. Once identified the only flexibility that the schema seem to offer is the occasional lexical change referring to an object, relation or concept in a domain knowledge. In that sense the schema-based approaches are not concerned with accounting for linguistic variation in the form of individual sentences, which account is at the heart of this thesis. Instead they concentrate on addressing the issue of how text is organised above the sentence level and in that they do not present an obvious basis for the model developed here.

2.4.1.2 Intention-Based Approaches: Plan-Driven Language Generation

In contrast with the schema-based approach the intention-based approaches rely on the general assumption that the form of language chosen by a speaker to encode a message reflects his intentions with respect to the hearer. There are two types of approaches within this category: the plan-driven approach which is concerned with characterising the sort of goals that the individual utterances may have, and the systemic grammar-driven approach which is primarily concerned with identifying the relationships between the goals and the surface forms that can be used to realise those goals.

In the plan-based approach to language generation originally proposed by Cohen and Perrault (1979); Perrault and Allen (1980); Appelt (1985) and Cohen and Levesque (1990), speakers' communicative goals constitute the central notion. Communicative goals are represented in terms of *plan operators* and plans are constructed for dialogues based on those operators. The operators encapsulate specific goals and the effects of those goals being achieved. For example, in the system proposed by Moore and Paris (1993), the operator shown in figure 2.2 has the effect of the hearer being persuaded to do some act. The goal represented in an operator can further decompose into more specific goals which when reached (i.e., when the planning process *bottoms out*) result in a surface form expression of communicative goals. The construction of plans typically enables an NLG system to identify relations between different operators which then leads to the construction of larger texts. For example in Moore and Paris' system, the

effect:	(PERSUADED ?hearer (DO ?hearer ?act))
constraints:	(AND (STEP ?act ?goal)
	(GOAL ?hearer ?goal)
	(MOST-SPECIFIC ?goal)
	(CURRENT-FOCUS ?act)
	(SATELLITE))
nucleus:	(FORALL ?goal
	(MOTIVATION ?act ?goal))
satellites: nil	

Figure 2.2: Example from Moore and Paris (1993) of the plan operator for a communicative goal of persuading.

relationships are determined based on Rhetorical Structure Theory (RST) (Mann and Thompson, 1988). In essence the theory provides a general description of the relations that hold between different segments (spans) of text.

Thus, just as is the case with the schema-based approach, the main concern of the plan-driven approaches is to provide a characterisation of the organisation of text above sentence level, rather than with characterisation of linguistic variation at the sentence level which is of central concern to the current model. This means that the plan-based approach does not present itself as an obvious basis for modelling the phenomena investigated here. Although planning refers explicitly to the speaker's intentions and to the effects that the speakers' linguistic actions may have on the hearer, the way in which goals are characterised reflects the traditional approaches to speech act categorisation in which acts are not understood as performing more than one function at a time. In Chapter 3 it will be demonstrated that a single corrective response may have more than one communicative goal. Planning together with the planning operators offer a good mechanism for modelling single functions for a single act, but not, as is required by

(1) S.REQUEST(A,S,PASS(S,A,SALT))
(2) B_S W_A(PASS(S,A,SALT))
(3)REQUEST(A,S,PASS(S,A,SALT))

Figure 2.3: Perrault and Allen's illocutionary levels for the direct request:*"Pass the salt."*

the model presented in this thesis, a mechanism for encoding multiple goals in a single linguistic act. In that sense they do not allow for the non-discrete nature of speech acts to be accounted for in any way.

Smilarly the plan-based analysis of indirect speech acts proposed by Perrault and Allen (1980) does not allow for an account of speech acts as respresenting non-discrete categories. This is because this approach relies on the traditional theories of speech acts such as those proposed by Austin (1962) and Searle (1969) in which a clear-cut distinction between acts such as INFORM and REQUEST is assumed. Given this assumption Perrault and Allen analyse indirect speech acts as essentialy the same as direct acts in terms of their illocutionary forces, but which forces are (a) represented by a different number of illocutionary (or speaker-hearer belief/intention) levels, and (b) are realised by different surface forms. For example, the differences in the illocutionary levels of the acts *"Pass the salt"* and *"Do you have the salt?"* are illustrated in figure 2.3 and 2.4 respectively. Essentially the recognition of the actual illocutionary force of an act depends on the recognition of the appropriate illocutionary level intended by the speaker, where the number of levels (and thus the complexity of belief/intention representation) characterising the direct acts is considerably less than that which characterises indirect acts.

Perrault and Allen's approach constitutes a valuable contribution to analysing indirect speech acts within the realm of the traditional, discrete speech act theories. However, with respect to the applicability of this approach to the linguistic analysis and to the model of language presented in the current thesis, it does not include any specification of how the choices of the different planning operators may be chosen and consequently how the different forms may be produced to encode the same illocution-

(1) S.REQUEST(A,S,INFORMIF(S,A,HAVE(S,SALT)))
(2) B_S W_A(INFORMIF(S,A,HAVE(S,SALT)))
(3) B_S W_A(KNOWIF(A,HAVE(S,SALT)))
(4) B_S W_A(HAVE(S,SALT))
(5) B_S W_A(PASS(S,A,SALT))
(6) REQUEST(A,S,PASS(S,A,SALT))

Figure 2.4: Perrault and Allen's illocutionary levels for the indirect request: *"Do you have the salt?"*

ary forces. As such then, the approach does not seem an obvious basis for the model developed in the current thesis.

2.4.1.3 Intention-Based Approaches: Systemic Functional Grammars

The systemic-functional grammar approach (e.g., Mann (1983); Bateman (1997)) also relies on the general notion of speakers' communicative goals in that it classifies different linguistic structures according to the communicative and social functions of linguistic acts that these structures can be used to encode. In this approach, the search space is organised around structure fragments and typically, as is the case in the PENMAN (Mann, 1983) and KPML (Bateman, 1997) systems, the generation process consists in traversals of the structure space in a manner of increasing specificity until all the relevant surface features are found. It is the communicative functions rather than the structural regularity of syntax that determine the organisation of the grammar. In this approach, surface form is viewed as the consequence of selecting a set of features from the systemic network. There are three types of functionalities represented explicitly in this formalism:

- *ideational functionality* which corresponds primarily to the propositional content, with example features including *process* and *participants*.

- *interpersonal functionality* which refers to the linguistic form as an action between hearer and the speaker, e.g., *imperative* or *interrogative mood* of an act.
- *textual functionality* which is concerned with the appropriate use of language in a particular context, e.g., *theme*, *rheme*.

The systemic grammars approach presents itself as a strong possible candidate for use with the current model not only because it relies on the fundamental assumption adopted here, namely that language is a form of activity with causes and consequences which motivate it, but also that it permits a representation of multiple goals (the overall function) to be expressed by a single act. However, despite this, the approach is problematic with respect to the phenomena modelled in this thesis for one very important reason: just as the plan-driven generation, functional systemic grammars rely on traditional speech act theories in which the communicative goals and the communicative functions of speech acts are discrete in nature. As is discussed in Chapter 3, the same communicative function or sets of functions may be expressed equally successfully by different linguistic means. On the other hand, even though the systemic approach could be used to represent multiple goals, their characterisation is nevertheless based on the assumption that these goals will correspond to a concrete, homogeneous class and equivocally appropriate surface representation. This is contrary to the approach taken in the current thesis, in which the membership of speech act classes is defined in terms of degrees to which linguistic forms can be characterised by those classes, and where the same linguistic forms can belong to more than one speech act type.

2.4.2 NLG systems based on the socio-linguistic theories

The application of the socio-linguistic theories of language use is still at a relatively embryonic stage. Only recently researchers concerned with modelling human-computer interaction have turned their attention to the affective and socio-cultural issues and begun to recognise that such issues refer to some essential aspects of the interactions and have the potential of making them more human like (Cassell and Bickmore, 2002). To date, the most significant advances of building interactional systems which make use of the socio-linguistic theories are within the area of embodied conversational agents. One example of how Brown and Levinson's theory may be applied to modelling language computationally can be found in the area of Speech Generation, and no examples are available to date within the domain of Intelligent Tutoring Systems. In this section the applications of the socio-linguistic theories to building conversational agents systems is briefly discussed to show the potential of involving such theories in computer systems and extending them to be more formally tight. Also the one application of Brown and Levinson theory to Natural Language Generation is discussed in detail as a way of illustrating the generative potential of this theory in the context of computer-based language generation.

2.4.2.1 Embodied Conversational Agents

The most solid, applied research on generating language based on socio-linguistic theories is that related to the **REA** project (Cassell and Bickmore, 2002). REA is an embodied agent which manifests human-like behaviour of a real estate agent in interactions with human clients. The agent incorporates several modules responsible for different parts of its behaviour such as body language, linguistic behaviour (turn-taking, interruptions, content elaboration and emphasis, conversation initiation and termination, etc.) as well as components which are responsible for detecting the human interlocutors' behaviour. With respect to the dialogue that REA can initiate and maintain, the system depends primarily on a discourse planner which is responsible for maintaining a list of conversation topics, prioritising the topics and selecting the appropriate speech acts to express the topics. The planner allows REA to mix topics related to the real task of selecting a property based on a clients requirements (these topics involve getting the necessary information from the client) with *small talk* topics which serve the purpose of introducing the air of familiarity and trust between the agent and a human.

In the context of this thesis, the most relevant part of REA lies in its handling of the speech act selection and the inclusion of the notion of face and facework in maintaining a good relationship with the clients. Cassell and Bickmore redefine Brown and Levinson's method for establishing face threat to be more in line with the proposals such as that of Spencer-Oatey (1992) discussed earlier in this chapter and which attempt to remedy some of the shortfalls of Brown and Levinson's model. Their definition of face relies on scalar dimensions of familiarity, solidarity, power and affect, where solidarity is equivalent to Brown and Levinson's social distance variable (D), familiarity is a variable which characterises the way in which the interpersonal relationships grow based on reciprocal exchange of information, starting with relatively non-intimate topics which gradually become more personal and private. This dimension can be further characterised by the familiarity depth (number of topics covered) and familiarity breadth (the shift from public to private). The affect variable refers to the liking that the interactants have for each other. Given those four dimensions Cassell and Bickmore define a face threat of an act: SA_{threat} to be a function of the class to which a given speech act belongs: SA_k (where act SA_k can be either SA_{STORY}, SA_{QUERY} or $SA_{STATEMENT}$), the discourse context of speech act into which SA_K will be introduced: ($\{SA_1...SA_j\}$), and the four scales of power, familiarity, solidarity and affect:

$$SA_{threat} = f(SA_k, \{SA_1...SA_j\}, Power, Solidarity, Familiarity, Affect)$$

The model developed by Cassell and Bickmore is more indepth than that of Brown and Levinson as it includes many proposed improvements discussed earlier in this chapter such as Fraser's rights and obligations and Spencer-Oatey's pragmatic scales. The main purpose for the redefinition of Brown and Levinson's theory is to capture the linguistic patterns of small talk in an interactive dialogue system. One very interesting part of their model is the ranking of the topics in terms of the threat that they pose vis à vis the depth and breadth of familiarity between the agent and a human. Furthermore, the incorporation of the facework in the planning of speech acts is extremely useful to modelling dialogues. However, Cassell and Bickmore's proposal can be applied reliably only to normal conversations. Specifically small talk is not conventionally part of educational exchanges between teachers and students as are not other techniques mentioned by Cassell and Bickmore for increasing familiarity. For example, teachers do not usually start with shallow-familiarity small talk concerning the weather, for instance, to break the ice and to open the opportunity for broadening and deepening the sense of familiarity between her and her student. Instead, teachers usually move on straight to the task at hand. In that sense the model used by REA may be as difficult to apply to educational context as was the simpler model proposed by Brown and Levinson. Furthermore, although Cassell and Bickmore mention the immediate context into which a speech act will be introduced, they do not define it in any way, which makes it difficult to see what contextual aspects are being modelled. From their description it is obvious that REA considers immediate circumstances such as the weather outside, the interlocutor, etc. as possible topics for conversation, but it is not obvious how these environmental aspects actually affect the assessment of the social acceptability of what REA says.

2.4.2.2 Linguistic Style Improvisation

Walker *et al.* (1997) developed a system for generating spoken linguistic variation based in full on Brown and Levinson's proposal. Their system for linguistic style improvisation (LSI) incorporates Brown and Levinson's theory within a planning component in which different types of speech acts are ranked, in what seems to be an arbitrary manner, to reflect the raking of imposition R_α that each type of act expresses. For every speech act modelled, a calculation of (face) THREAT Θ is done in an identical way to that in which Brown and Levinson's W_x is calculated, i.e. by summing the values of D, P and R_α. The value of Θ is then used to select an appropriate strategy. The strategies modelled by the LSI system correspond directly to the four main strategies proposed by Brown and Levinson. Each strategy belongs to a numerical range between 0 and 50 and can be realised by a multitude of sub-strategies which have further specific numerical ranges assigned to them. For each strategy the LSI planner selects the SEMANTIC CONTENT and the SYNTACTIC FORM by which the strategy will be realised. The surface realisations are either assigned heuristically to the upper or lower ends of a particular range, or to the same values in the range to support random variation. Just as Cassell and Bickmore have extended Brown and Levinson's theory, Walker adds an extra dimension to their model, namely the affective dimension, though this extension is minimal and is not included in the calculation of W_x. Instead, they characterise each character in the interactions within which they tested their system with an emotional predisposition at the start of the interaction.

The LSI system is a valuable example of using the theory of linguistic politeness in the context of a natural language generation system. Just as REA does, LSI demonstrates how such a theory may be incorporated in planning of speech acts by combining the selection of semantic content with the assessment of face threat that a speech act may pose. However just like the REA system, and Brown and Levinson's theory itself, its applicability to the educational context is not immediately obvious. The fact that LSI relies entirely on Brown and Levinson's model makes it open to the same criticisms as the theory itself, with the main problem being the linear calculation of the face threat and the definition of Face. Furthermore, it is not apparent from the description of the model what are the factors which potentially affect the values of P and D. In the model presented in this thesis, Brown and Levinson's theory is adapted to suit the educational interaction, while situational context is explicitly and directly used to calculate the affordable level of threat. The main difference between LSI and REA and the current model is that the last is not intended as an interactive dialogue system. Instead it constitutes a workbench for testing the correspondences between different situational contexts and the types of linguistic realisations which can be afforded in such contexts.

The current model is concerned with how to correct a student in a specific, isolated situation, with the assumption that such a situation is the result of previous interactions with the student. Furthermore, the model is not used to do a full language generation in the sense of content selection and aggregation. Instead its linguistic choices consist in entire, "ready-made" linguistic acts which are stored in a case-base. However a natural way to extend the current model would be to adapt it for the purpose of (a) a full language generation, and (b) a dialogue system. In such a case, as was indicated earlier, the need for a planning facility would seem apparent.

The details of the further work are given in Chapter 9, where the current model is discussed in the context of a proper, in the traditional sense, approach to Natural

Language Generation.

2.5 Summary

In this chapter research relevant to the current thesis was reviewed and the contributions of the various theoretical proposals were discussed in the context of the model presented here. The research in theoretical linguistics, especially that concerned with linguistic politeness and educational research were identified as the most relevant areas. Some of the most common traditional approaches to NLG were reviewed and the reasons for them not being used in the implementation of the current model were explained. Two contributions in the area of natural language generation were also discussed as a way of exemplifying the possibility of the linguistic theories being applied computationally. No applications of such theories to generating language in the context of educational interactions seem to be available to date, rendering the model presented in this thesis to be the first in this area. The different theories of linguistic politeness were reviewed and the use of Brown and Levinson's theory in developing the current model was justified in their context. The educational accounts of teachers'/tutors' language were presented and the way in which they contribute to the analysis of the linguistic data and to the model in general was explained. In the following chapters, the relevant research is referred to when appropriate with the details of the various theories used being contained in this chapter.

Chapter 3

The Linguistic Data Analysis

3.1 Introduction

This chapter presents an analysis of teachers' responses to students' incorrect or partially correct actions. The purpose of such an analysis is to determine the sort of language that teachers tend to use in the situations in which they need to address a student's misconception.

The chapter presents the analysis of two sets of dialogues referred to as the *Pittsburgh* and the *Polish* dialogues respectively. The Pittsburgh dialogues constitute the main set and the results of their analysis are used as the primary basis for the model developed in the current thesis. The Pittsburgh dialogues were gathered for a project called *A Computational Model of Tutorial Dialogue* at Pittsburgh University (Penstein-Rose *et al.*, 1999) and their domain is basic electricity and electronics. Although the analysis presented in this chapter is primarily of the Pittsburgh dialogues, the results of the analysis of the Polish dialogues are used to support the claims made throughout the chapter. Excerpts of Polish, spoken, classroom dialogues transcribed in Wojtczuk (1996) were analysed. Their domain was literary analysis. The main purpose of analysing the Polish dialogues was to acquire a more language universal, cross-cultural perspective on the language produced by teachers. It was also to determine whether or not the types of linguistic phenomena found in the dialogues about very procedural types of knowledge such as learning about basic electricity and electronics could be also found in other, more discursive domains such as literary analysis.

Section 3.2 presents the entire analysis of teachers' responses to students' erroneous actions as found in the two sets of dialogues, In section 3.3 the responses are classified which classification shows that speech act categories are non-discrete in nature.

3.2 Teachers' Corrective Responses

The focus of the current analysis is on the type of language produced by teachers in response to students' incorrect or partially correct actions or answers. There are two main reasons for this focus. The first motivation derives from a general recognition of the fact, referred to throughout the educational literature, that such situations present important opportunities for successful teaching and learning. On the one hand, it has been observed that deep, long-term learning happens when a student realises his misconceptions (Graesser and Person (1994); (1995)) . Typically, such realisation occurs during a *cognitive conflict* which consists in a student realising the incompatibility between his reasoning and his expectations vis à vis the results that should, but do not, follow from such reasoning (e.g., Piaget (1985), Chi *et al.* (2001)). On the other hand, such situations present important opportunities for the teachers as they allow them to discover the exact problems in a student's reasoning, to guide them out of their misconceptions, and to reinforce a student's deep learning of correct knowledge.

Not all types of guiding are suitable for all students and thus typically a teacher needs to adapt her guidance (the amount of it and the manner in which it is given) according to the cognitive and emotional needs of individual students. Thus, at one extreme there may be students who are confident, interested and generally able, and in such cases the guidance required by them may be minimal. At the other extreme there may be students who are shy, bored and whose progress is slow, which means that such students may require the teacher to provide them with more specific and more structured type of guidance. Moreover, in such cases the teacher may need to give some sort of explicit encouragement to address the student's lack of confidence, for instance. Typically, most students will fall into a middle category in which the individual differences between their cognitive and emotional needs are just as important as between the extreme cases, but which differences are observable on a much finer-grained level. In theory, a teacher may have to adjust her guiding in as many ways as the number of students that she teaches. Furthermore, the teacher may have to change the amount of guidance and the manner in which she delivers it for the same student whose characteristics and needs may change throughout an exchange. For example a student whose progress is slow at the beginning of a lesson may suddenly become more competent; a disinterested student may unexpectedly find a part of a material interesting, etc. This is a crucial observation, because given that most of human-human, teacher-student interactions occur via natural language, the different ways in which the teacher may have to adjust the guidance provided by her to the student, leads to an expectation that her language will vary according to the different adjustments.

The analysis of the dialogues justifies this expectation. The data shows that teachers' language when produced in response to students' erroneous actions is characterised by a significant linguistic variation as expressed by the different syntactic forms. One of the most striking aspects of such responses is that they express essentially the same main illocution, namely the *rejection* of the students' incorrect answers. Both the linguistic variation as manifested in the multitude of syntactic forms, and the fact that these different forms are used by teachers to encode the same main illocution are illustrated in example 3.1 through to 3.3, where 3.1 and 3.2 constitute the context to the responses in 3.3. All of the examples in 3.3 are responses produced by the same tutor in the Pittsburgh dialogues in reaction to various students' incorrect answers to the same question. The student's answer shown in 3.2, is just one example of an incorrect answer given by the students.

(3.1) **T's question:** What is needed to light a light bulb?

(3.2) **S' answer:** Heat (*incorrect answer*)

(3.3) (a) T: No, that's incorrect. (*Declarative*)

(b) T: Try again. (*Imperative*)

(c) T: Well, why don't you try again? (*Interrogative*)

(d) T: Well, if you put the light bulb in the oven, it would get a lot of heat, but would it light up? (*Interrogative*)

(e) T: Is it heat or the source that is needed to light a light bulb? (*Interrogative*)

The responses given by the teacher in 3.3 vary on the syntactic level from declarative, through imperative, to interrogative forms. The responses also vary with respect to the specificity with which they express the illocution of rejecting a student's incorrect answer (*illocutionary specifi city*), and in terms of specificity with which they refer to the answer sought by the teacher (*content specifi city*). With respect to the illocutionary specificity, 3.3(a) and 3.3(b) are the most specific, while 3.3(c), 3.3(e) and 3.3(d) are the least specific. On the other hand, in terms of content specificity, 3.3(a), 3.3(b) and 3.3(c) are all equally unrevealing with respect to the answer sought by the teacher, followed by the response 3.3(d) which makes a relatively strong reference to the content sought, while 3.3(e) almost gives the answer away to the student. While illocutionary specificity is typically referred to in the literature as indirectness (e.g., Grice (1989); Searle (1969); Brown and Levinson (1987)), content specificity is indirectly referred to as hinting (e.g., Fox (1991); Person *et al.* (1995)). In this chapter and throughout the thesis it is argued that in the educational circumstances under investigation here, linguistic indirectness is a result of teachers varying the degrees of both the illocutionary and the content specificity.

In order to model teachers' language production in situations in which students' erroneous actions need to be addressed, it is necessary to answer two interrelated questions:

- What communicative goals are teachers able to achieve by varying the levels of illocutionary and content specificity?

- How can the different linguistic acts produced by teachers in such situations be classified to allow for the process of selecting similar responses to be automated?

To answer these two questions, a closer look at the linguistic data is necessary. This is carried out in the following subsections, where all the types of teachers' corrective responses as found in the dialogues studied are listed and assessed with respect to the degree of illocutionary and content specificity encoded by them, and with respect to their possible communicative functions.

3.2.1 The Data Available and the Methodology Used in the Analysis

As was stated briefly at the beginning of this chapter, the linguistic data available consisted in two sets of dialogues: *(a)* 3 excerpts of spoken classroom dialogues conducted in Polish between three different teachers and a group of students (the Polish dialogues), and *(b)* 67 full lesson dialogues in American English between one tutor and approximately thirty four different students at the University of Pennsylvania (the Pittsburgh dialogues). While the Polish dialogues are all transcribed by Wojtczuk (1996) from audio recordings of face-to-face interactions between the students and three teachers, all of the Pittsburgh dialogues were conducted on a one-to-one basis and were typed. In the Pittsburgh interactions the student and the tutor did not see or hear each other. Instead they interacted via a computer link which also allowed the students and the tutor to see the same things on their respective computer screens.

Thus, the Pittsburgh and the Polish dialogues represent two different modes of communication in that (1) the Pittsburgh dialogues are not face-to-face whereas the Polish dialogues are face-to-face, (2) the Pittsburgh dialogues are conducted on a one-to-one basis whereas the Polish dialogues are conducted under one-to-many conditions, and (3) the Pittsburgh dialogues are typed whereas the Polish dialogues are spoken. As a consequence this may determine the type of responses produced by both the teachers and the students. For example, because of the mode of communication imposed on the Pittsburgh students, they do not have as much freedom as the the Polish students to respond with silence. The Pittsburgh tutor may be forced to prompt or to respond in a more explicit a manner to compensate for the lack of a face-to-face contact in constrast with the Polish teachers who have the luxury of being able to use gaze, facial expression, gesture as well as strategic silences. While the differences in the modalities of the two sets of dialogues may have an impact on an analysis of a wide range of responses used by teachers in educational circumstances in general, owing to the relatively narrow focus of the current analysis, i.e. only teachers' corrective responses are considered, the differences in the modalities have little impact on the results of the analysis. As is shown throughout this chapter, most types of corrective responses that are found in the Pittsburgh dialogues are also present in the Polish dialogues. However, the differences in the modalities used may occasionally impact on the interpretation of the appropriateness of the student's answer as is signalled later in this chapter in the example 3.53 on page 98.

While all three of the Polish dialogues were of approximately the same length, the Pittsburgh dialogues differ from interaction to interaction: some interactions involve only a few respective turns on the tutor and the student part (making a total of 1 to 2 A4 sized typed pages), while some go on for quite some time (20 or more pages). Because of this, some of the Pittsburgh dialogues did not qualify for the current analysis as they did not contain any student erroneous actions, and hence only a subset of the data available was analysed.

Owing to the fact that the model presented in this thesis evolved over the course of two years, both the Polish and the Pittsburgh dialogues were analysed twice over those years. The purpose of the first analysis was to gain a general understanding of the type of linguistic patterns present in teachers' language without the emphasis on teachers' responses to student erroneous actions. The second phase of the analysis was concerned specifically with finding and classifying the types of responses that teachers made to students' incorrect and partially correct actions. The second phase of the analysis was also used to find evidence of certain contextual situational factors influencing the form of the tutor's responses – this part of the analysis is reported in Chapter 4.

In the first phase of the analysis, all of the Polish dialogues were examined. In the case of the Pittsburgh interactions 10 of them were actually analysed which constituted the total number of interactions available to the author at the time. In the second phase of the analysis, again all of the Polish dialogues were used. In the case of the Pittsburgh dialogues all of them were read in detail by the author during the process of annotating all of the student answers to the tutor's questions for *correctness*[1]. In the second phase of the analysis, 23 Pittsburgh interactions were actually analysed in detail, making for a total of thirty three dialogues being analysed in both phases. This amounts to almost half of all the Pittsburgh dialogues. In the second phase, the dialogues were selected on a semi-random basis with the only constraints being that each interaction consisted of at least one erroneous student action and a tutor's recognition of the error in the form of the corresponding follow-up response [2].

In total, there were 87 teacher responses to students' erroneous answers analysed in the Polish dialogues. However, because in these dialogues the students' answers were not annotated for correctness, it is difficult to claim for sure how many of the teachers' responses were responses to completely incorrect student actions and how many of them were to students' partially correct actions[3]. In terms of the Pittsburgh dialogues there were altogether 194 tutor responses analysed, 110 of them were answers to incorrect student actions, and 54 were responses to students' partially correct actions. The percentages associated with the individual categories of responses presented in this chapter are based on the cases analysed. The results of the analysis of the Polish and the Pittsburgh dialogues are discussed together, but the percentages associated with different types of responses refer only to the Pittsburgh dialogues, due to lack of the Polish data being annotated for correctness formally.

[1]There were six correctness categories in the "correctness" coding scheme developed for a project independent of this thesis (see Core (2001)). The categories included the following: *correct*, *partially correct*, *incorrect*, *student doesn't know*, *irrelevant* and *cannot classify*.

[2]As Person *et al.* (1995) and Chi *et al.* (2001) amongst others, observed, tutors notoriously fail to respond to student erroneous actions. In some cases, during the Pittsburgh interactions, the tutor either does not notice the error or notices it only after a few turns later, in which case she usually admits to it. These cases were not included in the analysis.

[3]Overall the student erroneous actions were fewer in the classroom settings than in the one-to-one tutorial settings. This may be attributed to the fact that the teachers often addressed a question to the whole class and in many cases the students were self-selecting to provide the answers. The author consulted two Polish teachers who were experienced in the domain of literary analysis, in order to verify that the teachers' responses were indeed corrective in the contexts in which they were produced.

The method of analysing the data was the same for both sets of dialogues. In both cases Sinclair and Brazil's (1982) classification of teachers' "talk" was used as the springboard for the analysis (for details of their approach the reader is referred to Chapter 2, section 2.3.1.1). Specifically their notions of *initiation* and *elicitation* were used to distinguish between the different cases in the dialogues. The notions of initiation and elicitation are useful because they allow one to examine teachers' individual responses from the point of view of the communicative goals that they convey and from the point of view of perlocutionary effects that they are likely to achieve. It is important to bear in mind that Sinclair and Brazil's approach refers to teachers' language in general and not, as is the case in the current thesis, to responses to students' erroneous actions. As a consequence, although useful, Sinclair and Brazil's initiation categories had to be extended to accommodate for the type of teachers' responses which convey more than one communicative goal, and to accommodate for the types of initiations and elicitations that Sinclair and Brazil did not include in their taxonomy, and which were nevertheless found in the circumstances currently under investigation.

The process of extending Sinclair and Brazil's taxonomy happened incrementally. First, all the corrective responses to students' actions were collected from the interactions analysed. In the first stage, Sinclair and Brazil's basic categories were used for annotating the surface forms. This accounted for some, but not all the goals that the forms seemed to convey in the contexts in which they occurred. An intuitive list of the missing initiations was constructed by the author for each response. In the final stage, the list was made systematic with respect to groups of initiations based on the comparison of all the initiations intuitively associated with each form. Although not used as a reliable basis for the teachers' corrective response classification, the syntactic categories proposed by Sinclair and Brazil were used to check whether they corresponded to the forms found in the dialogues. As a result, the number of syntactic categories had to be extended by further types not accounted for by Sinclair and Brazil's taxonomy.

In the rest of the chapter the results of the analysis of the two sets of dialogues are presented and discussed. Because Sinclair and Brazil's classification is used as the basis for developing a taxonomy of teachers' corrective responses, explicit references are made to their approach. Otherwise the chapter describes the original contribution by the author of this thesis.

3.2.2 The General Patterns of Teachers' Corrective Responses

The most striking finding made on the basis of both sets of dialogues is the fact that the vast majority of teachers' linguistic actions consist of questioning acts. This finding is in agreement with recent research on teachers' language. For example, one account of Polish teachers' use of language in classroom situations suggests that at least 50% of all types of constructions used by them are questions (Laskowska, 1989). However, not all of the acts which are encoded by the interrogative syntactic forms are used by teachers as responses to students' erroneous actions.

Altogether, in the dialogues studied, there seem to be three general types of questions that teachers ask their students, which types are referred to here as *straight questions*, *test questions* and *hidden negative questions*[4]. *Straight questions* are content seeking questions, and just as questions are conventionally understood (Sadock, 1971), they imply a degree of ignorance on the part of the speaker . *Test questions*, which are content seeking, are produced as *initiations* which elicit knowledge from the students for the purpose of that knowledge being assessed by the teacher. This is a conventional way of describing the primary communicative function of most questions produced by teachers in educational circumstances (Sinclair and Brazil, 1982) – see for example, the teacher's question in 3.1. *Hidden negative questions* are produced strictly as responses to students' erroneous actions. In part, they may have the same communicative purposes as the straight and the test questions, and indeed their syntax may be the same, but their main illocutionary force is that of *rejecting* a student's incorrect answer. These types of questions are used to *hide* the rejection to varying degrees depending on a situation and a student, and this is where they derive their name from. Hidden negative questions belong to a larger group of acts produced by teachers in response to students' errors, and which are generically referred to in the current analysis as the

[4]These category names are proposed by the author of this thesis.

hidden negatives group. Examples of hidden negative questions are 3.3(d) and 3.3(e).

Apart from questions, teachers also produce *negative assertions* which are typically encoded by declarative forms, as well as *instructions* encoded either by imperative syntactic forms or by indirect interrogative forms. While the instructions and the indirect questions almost invariably belong to the hidden negatives class, some types of negative assertions may not be hidden and therefore they may fall outside of the hidden negatives group. The details of the analysis with respect to assertions and instructions are given in subsection 3.2.5.

3.2.3 Straight questions and test questions

Although the main focus of the current analysis is on the responses to students' erroneous answers, for completeness the explanation of the communicative functions of straight questions and test questions is also included here. The analysis of these questions is used also to outline, later in this chapter, the syntactic, semantic and pragmatic peculiarities of the questions asked by teachers in response to students' errors.

On a general level, both straight and test questions constitute conventional questions in that they imply a degree of ignorance on the part of the speaker (Sadock, 1971). However they differ from one another with respect to the types of ignorance that each of them implies. While straight questions imply ignorance of the actual subject matter, i.e. they imply lack of beliefs on the part of the speaker, test questions imply speaker's ignorance of the actual nature of the beliefs that the hearer may have.

(3.4)

(a) What do you mean by this?

(b) How do you figure that?

(3.5)

(a) *Co przez to masz na myśli?*
What by this you have on thought?
'What do you mean by this?'

(b) *Jak do tego doszedłeś?*
How to this you got?
'How did you get to this [conclusion]?'

Thus, a teacher may ask questions such as 3.4(a), 3.4(b), or in Polish 3.5(a) and 3.5(b) in a situation when she genuinely requires the student to provide her with information of which she has no prior knowledge, or when there is a clear lack of understanding on her part as to the student's responses. In such situations, these questions are not intended as confrontational.

In contrast to straight questions, test questions are not asked out of the speaker's ignorance. Unlike participants of normal conversations, teachers often already know the answers to the questions they ask. This is one of the underlying facets of the educational form of dialogue which constitutes part of the conversational contract between the teacher and the student. Thus, in a casual conversation questions 3.6 and 3.7 could be interpreted as straight questions. However in an educational dialogue, they could be only interpreted as such if they were produced by a student. If uttered by a teacher, they have only one interpretation – that of test questions.

(3.6)

(a) Is heat sufficient to light a light bulb?

(b) What is needed to light a light bulb?

(3.7)

(a) *Czy elegia jest utworem nostalgicznym?*
Question word elegie is literary work nostalgic?
'Is elegie an nostalgic piece of literary work?'

(b)	*Czy*	*ktoś*	*może*	*mi*	*powiedzieć*	*co*	*to*	*jest*	*anafora?*
	Question word	somebody	can	me	tell	what	it	is	anaphora?

’Can somebody tell me what is anaphora?’

On the syntactic level the test questions in 3.6(a) and 3.7(a) constitute *positive polarity* interrogative forms. Another form, frequently used in the dialogues to perform the function of a test question is *WH-word* form exemplified by 3.6(b) and 3.7(b). Note with respect to 3.7(b) that, strictly speaking, it could be interpreted as a straight question with an embedded test question. However the reason for classifying it as a test question is simply that the felicitous response to it is not a *’yes’* or *’no’* answer as it would be to a straight question, but specific content. The positive polarity and the WH-word questions differ from one another on the semantic level as is illustrated by Sinclair and Brazil’s classification, presented in Chapter 2, in which the difference between the positive polarity and the WH-word questions is that the first elicits a *decision* from the student, while the latter elicits *content.* This is true of both the English and the Polish uses of these forms of initiations, which is illustrated in examples 3.8 and 3.9, and 3.10 and 3.11 respectively.

(3.8)

(a) T: Is the source needed to light a light bulb?

(b) S: Yes, it is. (*decision between “yes, it is needed” and “no, it isn’t needed”*)

(3.9)

(a)	*Czy*	*elegia*	*jest*	*utworem*	*nostalgicznym?*
	Question word	elegie	is	literary work	nostalgic?

T: ’Is elegie a nostalgic piece of literary work?’

(b) *Tak.*
Yes.
S: ’Yes.’ (*decision between “yes, it is nostalgic” and “no, it isn’t nostalgic”*)

(3.10)

(a) T: What is needed to light a light bulb?

(b) S: A source. (*content*)

(3.11)

(a)

Czy	*ktoś*	*może*	*mi*	*powiedzieć*	*co*	*to*	*jest*	*anafora?*
Question word	somebody	can	me	tell	what	it	is	anaphora?

T: 'Can somebody tell me what is anaphora?'

(b)

Anafora	*to*	*jak*	*autor*	*powtarza*	*to*	*samo*	*słowo*	*na* *początku*
Anaphora	this	like	author	repeats	this	same	word	on beginning

każdego	*wersu.*
of each	verse.

S: 'Anaphora is when the author repeats the same word at the beginning of each verse.' (*content*)

According to Sinclair and Brazil, in general teachers also use other interrogative forms such as *negative polarity* questions illustrated in examples 3.12 and 3.13, with the expected English response being: "*Yes, it is.*", and *tag* questions (Stockwell *et al.*, 1968) exemplified in 3.14 and 3.15, with the expected type of English response also being "*Yes, it is.*". These question types can be also interpreted in certain circumstances as testing.

(3.12) Isn't it source that is needed to light a light bulb?

(3.13)

Czy	*elegia*	*nie*	*jest*	*utworem*	*smutnym?*
Question word	elegie	not	is	literary work	sad?

'Isn't elegie a sad type of literary work?'

Although negative polarity questions occur regularly in the Pittsburgh dialogues, there is no evidence at all of the tag questions being used by the Pittsburgh tutor. Similarly, there is no evidence of the Polish equivalents of English tag questions in the Polish dialogues. Nevertheless, possible English (3.14) and Polish (3.15) examples of such constructions are included here for completeness.

(3.14) Electricity is sufficient to light a light bulb, isn't it?"

(3.15)

Elegia	*wyraża*	*cześć*	*jaką*	*poeta*	*oddaje*	*umarłej*	*osobie,*
Elegie	expresses	honour	which	the poet	gives back	to dead	to person,

tak?
yes?
Approximately: 'Through elegie the poet honours a dead person, doesn't he?'

Sinclair and Brazil's taxonomy allows one to speculate as to the possible communicative purposes of at least some of the test questions. Assuming that the purpose of test questions is to elicit responses from a student in order to verify them against some desired answers which are already known to the teacher, it is possible to interpret the positive polarity and the WH-word questions in particular as being used to check *what* and *how much* the student knows (*content* and *quantity* of knowledge respectively), and *how well* he knows it (*quality* of knowledge).

Intuitively, the choice of a particular test question may be related to a teacher's beliefs about the quantity, the quality and/or the content of a student's knowledge. For example, WH-word questions may be asked to test a student's quantity of knowledge through eliciting content, while the positive polarity questions may test the quality (or the strength) of the student's knowledge by virtue of eliciting a decision.

Furthermore, the concept of quantity as associated with elicitation of content, and the concept of quality as associated with the elicitation of a decision, seem inherently linked with the notion of content specificity. In order to test for content and for the quantity of the student's knowledge, it is likely that the teacher will avoid any explicit reference to the actual answer sought in order to induce deep reasoning in a student. Graesser *et al.* (1995) make similar distinctions between different types of questions asked in educational circumstances and refer to the content eliciting questions as the *deep questions.* Thus, assuming that the answer sought by the teacher is *"A source is needed to light a light bulb"*, example 3.10 which elicits content and hence also tests for quantity, contains no reference whatsoever as to the answer desired by the teacher.

On the other hand, in order to test for the quality of student's knowledge, the teacher may have to refer to the possible solution, because this kind of testing typically involves a student's decision regarding the truth of a particular phenomenon being the case as presented to him by the teacher. Examples 3.8 and 3.9 which are used to elicit a decision, and hence to test for the quality of student's knowledge, give relatively strong clues as to the answer sought. It is the strength of the student's knowledge that will cause him to make the decision. If the student's beliefs as to the *source* being the right answer are weak he may decide against a positive reply, while if they are sufficiently strong the teacher's deceit will not work and the student will provide the correct answer to the teacher's question, thereby confirming the quality (or the strength) of his knowledge.

Also the agreement initiation, which Sinclair and Brazil associate with the negative polarity and the tag questions, sheds light on the possible level of content specificity needed to be encapsulated by such questions. Both negative polarity and tag questions elicit agreement. In order to agree, a person needs to have a sufficient amount of information regarding the object of the agreement available to them. This suggests that the level of content specificity in both cases needs to be quite high for such an elicitation to succeed. The strong reference to the content sought that is expressed by the negative polarity and the tag questions is shown in the examples 3.16 and 3.18 and their Polish equivalents 3.17 and 3.19 respectively.

(3.16)

(a) T: Isn't source the component needed to light a light bulb?

(b) S: Yes. (*agreement*)

(3.17)

(a)	*Czy*	*elegia*	*nie*	*jest*	*utworem*	*smutnym?*
	Question word	elegie	not	is	literary work	sad?

T: 'Isn't elegie a sad type of literary work?'

(b) *Tak.*
Yes.
S: 'Yes [it is].' (*agreement*)

(3.18)

(a) T: Source is the component needed to light a light bulb, isn't it?

(b) S: Yes. (*agreement*)

(3.19)

(a)

Elegia	*wyraża*	*cześć*	*jaką*	*poeta*	*oddaje*	*umarłej*	*osobie,*
Elegie	expresses	honour	which	the poet	gives back	to dead	to person,

tak?
yes?
T: 'Through elegie the poet honours a dead person, doesn't he?'

(b) *Tak.*
Yes.
S: 'Yes [he does].' (*agreement*)

Although it is possible to imagine the negative polarity and the tag questions performing the function of test questions as the positive polars do, the high content specificity of tag questions suggests that they do not belong to the same class as the purely testing questions which elicit content or decision. Instead, they perform a very strong information giving function of telling the student the answer sought. This is particularly striking when the examples 3.16 and 3.18 are compared with the informing initiation shown in 3.20.

(3.20)

(a) T: Source is the component needed to light a light bulb.

(b) S: OK. (*acknowledgement*)

The content specificity in all of the three acts is equally high, i.e. the answer is practically given away to the student. However, by comparing 3.16 and 3.18 with 3.20, it becomes apparent that while 3.20 constitutes a *direct* linguistic act, the two interrogative forms encode *indirect acts.* In other words, the communicative purpose of 3.20 seems to be much more straight forward (it is to inform the student about the content matter) than that of the acts in 3.16 and 3.18 respectively. While, on the one hand the purpose of the negative polarity and of the tag questions is to inform the student about the content matter, the two questions also seem to be giving the option to the student not to accept the information provided to him by the teacher. In that sense they can be understood as testing (or pretending to test) the student by eliciting a decision from him. The student is given a possibility of responding otherwise than by acknowledgement which, conventionally, is the fit response for the purely informative elicitations. This means that neither the negative polarity nor the tag questions can be fully accounted for by the singleton types of elicitations proposed by Sinclair and Brazil. The communicative functions of these constructions are at least as complex as can be expressed by the dual purpose of informing and of testing the student's knowledge. But the indirectness of the forms in 3.16 and 3.18 begs a question as to the purpose of a teacher giving her student an option not to accept her act of informing.

A possible answer to this question emerges from a closer examination of the situations in which the negative polarity questions[5] are produced and which suggests that their respective communicative functions may be even more complex than the dual function just proposed. In both sets of dialogues studied, the negative polarity (and their Polish equivalents) virtually never occur in the straightforward testing situations. Instead, they are frequently found to be used by teachers as responses to students' incorrect actions. Based on this observation coupled with the fact that these acts are not easily characterised by a single type of elicitation it is proposed that they belong to a different class than the purely testing class of teachers' questions, namely to the class named here the *hidden negatives*. The question regarding the purpose of using the interrogative forms to inform the student is thus explained in the process of analysing the hidden negative acts which is described in the following sub-sections.

[5]Given that tag questions have not been found at all in either data set, they are not included in the remainder of the analysis.

3.2.4 Hidden Negatives

Hidden negatives (as opposed to hidden negative questions) constitute a class of linguistic acts which are produced by teachers in response to students' erroneous actions. Overall, based on the Pittsburgh dialogues they constitute approximately 46.3% of all responses produced by teachers to student erroneous answers. Their main communicative purpose is to inform the student that his previous action was incorrect in a non-explicit manner. There are many different syntactic encodings of hidden negatives which span from declarative forms, through imperatives, to interrogatives. All of the forms discussed here are summarised later in the chapter in table 3.1 to which the reader is referred to if needed.

3.2.4.1 Examples of the syntactic encodings of hidden negative questions

The syntactic interrogative forms which are used to encode hidden negative type of linguistic acts are exactly the same as most of those used to encode the straight questions and test questions listed in Sinclair and Brazil's classification. Thus, hidden negative questions are encoded by positive polarity (6.4% of all the hidden negative questions), negative polarity (6.4% of all the hidden negative questions) and WH-word questions (41% of all hidden negative questions). However there is no evidence in either set of dialogues for tag questions being used as responses to students incorrect actions. Other syntactic forms include hybrids such as shown in the examples 3.21 and 3.22 (which are currently given the name of If-Then hidden negative questions and which are found in the Pittsburgh dialogues in 24.3% of all cases of hidden negative questions).

(3.21) If you put the light bulb in the oven it would certainly be getting a lot of heat but would it be likely to light up?

(3.22) Wires help, but if you hook a wire to a light bulb and nothing else, will it light up?

Example 3.24 is of a WH-word question used for a different purpose than the content-seeking associated with these constructions by Sinclair and Brazil. To distinguish such examples from the content-seeking WH-word forms, they are referred to as explanation-seeking WH-word questions. The explanation-seeking WH-word questions constitute 21.8% of all hidden negative questions. Neither the If-Then nor the explanation-seeking WH-word questions can be easily classified as belonging to any of the types of questions discussed by Sinclair and Brazil. As shown in 3.23 and 3.25 respectively, similar forms are also found in the Polish dialogues.

(3.23)

Jeżeli	*poeta*	*chciałby*	*napisać*	*utwór*	*na*	*cześć*	
If	poet	would want	to write	a literary piece	in	honour	
kogoś	*umarłego*	*to*	*czy*	*rzeczywiście*	*oda*	*byłaby*	
of somebody	dead	then	question word	really	ode	would be	
stosowną	*formą?*						
suitable	form?						

'If the poet wanted to write a piece in honour of a dead person, then would ode be really a suitable form?'

(3.24) Why would you say that?

(3.25)

Dlaczego	*tak*	*mówisz?*
Why	like this	you say?

'Why do you say so?'

Clearly, none of the examples are either negative or positive polarity questions nor are they tag questions, because none of them contain the required question words: the sentence initial *"is/isn't"* in the case of the positive and negative polarity questions, and sentence final *"isn't it?"*, *"does it?"*, etc., in the case of tags. For similar reasons the questions in 3.21, 3.22 and 3.23 cannot be classified as WH-word questions as they lack the WH–, sentence initial word required to allow for such a classification. Yet, the hybrids, henceforth referred to as *if-then questions*, are found to be used frequently by teachers as responses to student's incorrect answers. Although in terms of their syntax, examples 3.24 and the Polish example 3.25 could be classified as WH-word questions, as will be explained shortly their communicative function differs from the type of acts typically embodied by the WH-word questions.

The interrogative forms in the examples from 3.21 to 3.25 are perceived in the current analysis as the prototypical hidden negative questions. This is because even outside their original contexts they carry a negative assertive force. In the current analysis, this negative assertive force is attributed to the presence of the polarity items such as *"but"*, *"nothing else"* and the Polish *"rzeczywiście"*. This force, or simply the illocution, is the rejection of a student's incorrect answer to the teacher's previous question. The negative polarity items along with the conditional frame *if-then* (Polish: *jeżeli-to*) and the question mark, allow for the rejection to be hidden and thus for its strength to be softened. It is precisely this covert character of their assertiveness that the hidden negatives derive their name from. That these forms encode the rejection of the student's incorrect answer is confirmed by the subsequent responses to such hidden negatives by different students. Thus, if examples in 3.21 through to 3.25 were treated as conventional questions then the expected student responses to 3.21 and 3.22 should be a *"yes/no"*. Instead, both questions invite further guesses on the students' part, in the case of the English examples currently used – as to the appropriate components of a light bulb that are necessary to light it, and in the case of the Polish examples as to the poetic form appropriate for honouring a dead person. The student answer to 3.21 is: *"No, I guess it must be the voltage source"*, while to 3.22 it is: *"OK, so also power is needed"*. It is clear in both cases that the students understood that the purpose of these questions was to inform them about the incorrectness of their previous answers and to invite them to further responding. Also, despite no initiative being taken by the Polish pupils in terms of trying for another answer, it seems clear from their (collective) response to the question in 3.23 (*"Nie"* = *"No"*) that they understood the teacher's message, i.e. that an ode is not a suitable literary form for honouring dead people.

The students' answers to the explanation seeking hidden negative questions such as 3.24 and the Polish equivalent 3.25 also suggest that these questions are understood by the students as informing them that there may be problems with their previous answer or action. Questions such as 3.24 are asked quite frequently in the Pittsburgh dialogues in response to students' erroneous actions and the student answers to them may vary. Very typical student answers to them include either *"I was guessing. I don't really know."* or *"OK"* followed by another guess. In the Polish dialogues the students typically react to questions such as 3.25 by either being silent, which may be partially a culturally determined aspect of Polish teacher-student classroom interactions (as a student you wait for the teacher to make the next move), and partially it may be due to the face-to-face modality used which permits such silences to be made felicitously, or the students simply say *"Nie wiem" = "I don't know"*.

3.2.4.2 Further characteristics of hidden negatives: the lexical level

On a lexical level, for a question to be classified as a hidden negative, it has to contain one or more *polarity items*, i.e. words that signal a contrast between the previous assertion and the current one. In the case of the positive polarity, negative polarity and some of the explanation seeking hidden negatives the most prominent polarity items are the question words *is/isn't* (in Polish: *czyż/czyż nie = is/isn't*) in the case of the first two and *would* (in Polish the conditional particle *"by"*) in the case of the third type. The most extreme case of a hidden negative question is that which is encoded by the form *"Why?"* (Polish: *"Dlaczego?" = "Why?"*), which is also shown in example 3.42. In this case the question word constitutes both the polarity item and the entire interrogative form. Note that including the question words such as "why" in the term *polarity item* extends the standard use of the word by items which signal contrast, and hence potential lack of agreement with or lack of acceptance of the entire immediately preceding act of the other person – in this case the student's action. Indeed, the Polish explanation seeking hidden negative seems to perform only such a contrastive function with respect to a student's previous answer[6]. Such questions are found rarely in the Polish dialogues and when found they are used by one of the three teachers in response to a clearly problematic student answer.

The polarity items strongly imply speakers' expectations as to the possible answer

[6]This reading was verifi ed with two native Polish speakers who are also experienced teachers with 40 years of experience each.

and are crucial in determining the strength of the rejection. Teachers intensify or lessen the negative force of what they say by choosing appropriate polarity items and by combining them within a single construction. Thus, 3.21, with only one such item, seems much more positive a question than 3.22, where two items are used and where one of them is an explicit negative noun *"nothing else"*. There are also other factors that contribute to this effect. For instance, there are different verb forms used in the respective questions. While in 3.21 a conditional aspect is used which results in a further cushioning of the rejection, the use of a conditional verb form in 3.24 and the use of the present tense in 3.22 result in the rejection of the student's answer being made more strongly.

3.2.4.3 Further characteristics of hidden negatives: the semantic level

On a semantic level, the hidden negatives seem much more complex than the analysis by Sinclair and Brazil allows one to account for. When examples such as 3.27 with the corresponding Polish construction in 3.29, and example 3.32 with the corresponding Polish example in 3.34 are considered with respect to the possible fit responses, the observation made earlier regarding the multiple communicative purposes being encapsulated by the hidden negatives seems to be supported. Except for the responses 3.28(c), 3.28(d), 3.33(c) and 3.33(d) (and the corresponding Polish examples: 3.30(b), 3.30(c), 3.35(b) and 3.35(c) respectively), the student's responses listed underneath the examples constitute all the responses proposed by Sinclair and Brazil as being fit for one of the types of initiations classified by them. The responses marked with an asterisk (*) represent those student answers which do not seem appropriate in the context of the English questions 3.27 and 3.32, and the Polish questions 3.29 and 3.34 respectively. The responses marked with a question mark (?) represent those student responses of which the appropriateness is marginal. For completeness the larger dialogue contexts to the tutor's corrective responses are provided for the Enlish examples. Both the teacher questions in 3.27 and 3.29 are positive polarity questions, while those in 3.32 and 3.34 are the hybrid *if-then* questions not accounted for by Sinclair and Brazil's classification.

(3.26) **Dialogue context to the corrective response 3.27:**

(a) **Teacher’s initiation:** What does the light bulb need in order to light up?

(b) **Student’s partially correct answer:** a power source (wall outlet), cord and switch.

(3.27) **Teacher’s corrective response:** Is it wall outlet or power source that is needed?

(3.28) **Student’s possible answers to Teacher’s corrective response 3.27:**

(a) *OK. (*acknowledgement*)

(b) *Yes. (*decision*)

(c) Source. (*content + decision*)

(d) OK, it’s the source. (*acknowledgement + decision + content*)

(3.29)

Czy	*poeta*	*rzeczywiście*	*wyraża*	*swoja*	*miłość*	*do*
Question word	poet	really	expresses	his own	love	to

bohaterki,	*czy też*	*pisze*	*o*	*tej*	*miłości*	*z*
the heroine	contrastive question word	he writes	about	this	love	with

ironią?
irony?

Teacher’s corrective response:’ Does the poet really express his love for the heroin, or is he ironical about it?

(3.30)

(a) **Tak.*
Yes.
Student’s answer: ’Yes.’ (*acknowledgement*)

(b)

Pisze	*o*	*niej*	*z*	*ironią.*
He writes	about	it	with	irony.

Student's answer: 'He writes about it with irony' (*content + decision*)

(c)

Tak,	*pisze*	*o*	*niej*	*z*	*ironią.*
Yes	he writes	about	it	with	irony.

Student's answer: 'Yes, he writes about it with irony' (*acknowledgement + content + decision*)

(3.31) **Dialogue context to the corrective response 3.32:**

(a) **Teachers' initiation:** What is the one (the most important) thing that a lightbulb needs in order to light up?

(b) **Student's incorrect answer:** heat.

(3.32) **Teacher's corrective response:** Well, if you put the light bulb in the oven it will certainly get a lot of heat, but will it be likely to light up?

(3.33) **Student's possible answers to Teacher's corrective response to 3.32:**

(a) *OK. (*acknowledgement*)

(b) No. (*decision*)

(c) Source. (*acknowledgement + content + decision*)

(d) No, the source. (*acknowledgement + content + decision*)

(3.34)

Jeżeli	*poeta*	*chciałby*	*napisać*	*utwór*	*na*	*cześć*
If	poet	would want	to write	a literary piece	in	honour

kogoś	*umarłego*	*to*	*czy*	*rzeczywiście*	*oda*	*byłaby*
of somebody	dead	then	question word	really	ode	would be

stosowną	*formą?*
suitable	form?

Teacher's question:'If the poet wanted to write a piece in honour of a dead person, then would ode be really a suitable form?'

(3.35)

(a) *Nie.*
No.
Student's answer: 'No.' (*decision*)

(b) *Nie napisałby elegię.*
No he would write elegie.
Student's answer: 'No, he would write an elegie.' (*acknowledgement + content + decision*)

(c) **Elegię.*
Elegie.
Student's answer: 'Elegie.' (*content + decision*)

Even in the case of the positive polarity questions (examples 3.27 and 3.29), it seems that when they are used to encode hidden negatives they may perform at least two types of elicitations, namely they may elicit content and decision at the same time, where the content is the overt realisation of the decision. Furthermore, just as is the case with the *if-then* questions, the positive polarity may perform even as many as three different elicitations, where the additional elicitation is the acknowledgement of the informative part of the linguistic act. While 3.27 is relatively content specific, it also seems to convey another type of *inform*, namely it conveys the information that the student's incorrect answer is rejected by the teacher. This type of inform is even more apparent in the case of the examples 3.32 and the examples 3.37 through to 3.44. In the case of 3.32 this judgement is based primarily on the presence of the negative polarity item "Well" at the beginning of the response. In the case of examples 3.37 through to 3.44 this judgement is more intuitive, based on the observation that none of these responses contain any positive feedback as to the student's previous answer. As Fox (1991) and Fox (1993) points out, the lack of immediate positive feedback, or a hesitation on the part of the teacher often indicates that there may be a problem with the student's answer.

In all of those cases the content specificity is low to very low. The student's actions are rejected, and the students' acknowledgements of the rejection in all of 3.33(c) and

3.33(d), 3.35(b), 3.38(c) and 3.38(d), 3.40(b) and 3.40(c), 3.43(c) and 3.43(d), and 3.45(b) and 3.45(c) refer to the students understanding of that rejection.

(3.36) **Dialogue context to the corrective response 3.37:**

(a) **Teachers' initiation:** It's really important that you understand the answer to this question before you continue with this lab.

(b) **Student's answer:** I thought that since power = resistance times voltage that increasing either value would increase the power. Is the objective to increase power?

(c) **Teachers' response:** Yes, the objective is indeed to increase the power. But you don't have the formula quite right.

(3.37) **Teacher's corrective response:** What formula do you need to calculate power?

(3.38) **Student's possible answers to Teacher's corrective response 3.37:**

(a) **?**OK. (*acknowledgement*)

(b) *Yes. (*decision*)

(c) P = I * E. (*acknowledgement + content + decision*)

(d) OK, it's P = I * E. (*acknowledgement + content + decision*)

(3.39)

Jak	*poeta*	*odnosi*	*się*	*to*	*tej*	*miłości?*	*Jakich*	*słów*	*używa?*
How	poet	refers	himself	to	this	love?	What	words	he uses?

Teacher's question: 'How does the poet refer to this love? What words does he use?'

(3.40)

(a) **Tak./Nie.**
Yes./No.
Student's answer: 'Yes./No" (*decision*)

(b) *Aha, mówi, że jest zdradliwa i przewrotna.*
Ah he says that it is treacherous and contrary.
Student's answer: 'Ah yes, he says that it is treacherous and contrary.' (*acknowledgement + content*)

(c) *Zdradliwa i przewrotna.*
Treacherous and contrary.
Student's answer: 'Treacherous and contrary.' (*acknowledgement + content*)

(3.41) **Dialogue context to the corrective response 3.42:**

(a) **Teacher's initiation:** [...] what happens if your resistor is less than 2500 ohms?

(b) **Student's partially correct answer:** it wouldn't work.

(c) **Teacher's corrective response:** Well, what exactly [wouldn't work]?

(d) **Student's partially correct answer:** the ammeter.

(3.42) **Teacher's corrective response:** Why?

(3.43) **Student's possible responses to Teacher's corrective response 3.42:**

(a) *OK. (*acknowledgement*)

(b) *No. (*decision*)

(c) Source. (*acknowledgement + content + decision*)

(d) Because .... (*acknowledgement + self-explanation*)

(3.44) *Dlaczego tak mówisz?*
Why like this you say?
Teacher's question: 'Why do you say so?'

(3.45)

(a) **Student's answer:** *silence* (*acknowledgement*)

(b) *No to w takim razie nie wiem.*
Well in this case not I know.
Student's answer: 'Well, in that case I don't know.' (*acknowledgement*)

(c) *Dlatego, że ....*
Because ....
Student's answer: 'Because ....' (*acknowledgement + self-explanation*)

Examples, 3.37, 3.39, 3.42 and 3.44 represent the hidden negatives as encoded by the WH-word construction. However, their communicative purposes may differ significantly as is demonstrated by the fit responses shown in 3.43(d), 3.45(b) and 3.45(c) which are responses to the types of initiations not accounted for by Sinclair and Brazil's taxonomy. Examples 3.37 and 3.39 are content-seeking WH-word hidden negatives, while examples 3.42 and 3.44 are explanation-seeking hidden negatives. In the case of the latter type, the initiation is to elicit an explanation from the student. This kind of elicitation is observed in the dialogues relatively frequently (21.8% of all corrective responses) and is confirmed by many educationalists and educational psychologists to be one of the most important factors responsible for students' deep learning (Graesser *et al.* (1995); Chi *et al.* (2001)).

While on a semantic level it has been argued that hidden negatives lead to multiple elicitations, a comparison of forms such as those presented in 3.27 and 3.32 suggests that these elicitations do not have the same priority in both cases. The different prioritisation may give rise to slightly different communicative objectives. In the case of 3.28(c), the decision takes priority over content (expressed by the order in which they are presented in the parenthesised gloss), while in the case of 3.33(c) and 3.33(d), content takes priority over decision. This prioritisation suggests that teachers elicit different types of reasoning on the students' part, where 3.27 seems to evoke a much shallower type of reasoning (the possible choices are spelled out) than 3.32 where the student is forced to perform a deeper inference to arrive at the correct answer. These are examples of the ways in which a teacher may provide the students with hints which are suitable for different students' cognitive needs, or for the cognitive needs of the same student either in different educational circumstances or with respect to different (aspects of the) material taught.

In the dialogues studied, the situations in which either of those forms are used also differ: 3.27 is typically produced after several incorrect student answers to the same question, while 3.32 tends to be produced after the first incorrect attempt by the student. Furthermore, intuitively, 3.27 seems less polite by virtue of almost giving the answer away to the student than 3.32 which allows the student more autonomy in deciding on how to tackle the problem at hand. It is then possible to see that the rules of polite behaviour as established by a given speech community and as they seep through from that community to educational settings, extend to and are adapted for the educational circumstances by the teachers. In other words, not only illocutionary specificity which is typically associated with indirect language use, but also content specificity may be interpreted as a dimension of socio-emotionally aware behaviour on the teachers' part, and as a dimension which contributes to the overall effect of indirectness. This point is elaborated in Chapter 4, where it is used as a basis for defining some of the prerequisites of the model of teachers' response selection presented in the current thesis.

3.2.4.4 Further characteristics of hidden negative questions: the pragmatic level

Finally, on a pragmatic level of analysis, it is possible to stipulate that teachers use hidden negatives to reduce the strength of the rejecting illocution which in turn allows them to avoid discouraging or intimidating the student from further learning. Straight rejections can be pedagogically counter-productive in that, in most cases, they leave no space for the student to explore either the issues taught nor their own misconceptions. Such rejections, through being demotivating to the student, may prevent him from further participation in the lesson and from communicating with the teacher. Such possible effects contradict the overall purpose of teaching.

Research in theoretical linguistics supports the assumption that teachers' may want to soften the blow of a rejection in order to motivate students' communication and cooperation. Fetzer (2003), for instance, points at the relation between the acts of rejection and indirectness in everyday language.

In short, following the proposals of other linguists such as Grice (1989), Goffman (1959) and Brown and Levinson (1987), Fetzer claims that *point blank* rejections of prior speech acts, such as those illustrated in the examples 3.46 and 3.47 are not generally realised by negative operators such as *"no"*[7]. Instead speakers behave according to certain *rules of politeness* which are established and maintained by a particular speech community and which dictate that the rejection be encoded by "additional language".

(3.46)

(a) Speaker 1: Do you want a cup of coffee?

(b) Speaker 2: No.

(3.47)

(a) Speaker 1: Can you tell me what time it is?

(b) Speaker 2: No.

The additional language allows the speaker to express the rejection without violating the established principles of politeness and is regulated by specific socio-cultural circumstances as encapsulated in an immediate situation in which an act is produced. That the rules of politeness apply in the educational contexts is also confirmed by studies such as that by Person *et al.* (1995), in which she demonstrates the enormous extent to which teachers use "polite" language, especially in situations in which they have to provide their students with corrective feedback (see discussion in Chapter 2). The relation between politeness and teachers' corrective responses is elaborated in detail in Chapters 4 and 6.

[7] Both examples are adapted from Fetzer (2003, p.138).

3.2.5 Negative assertions and instructions

Negative assertions (53.5% of all the teacher's responses to student erroneous actions analysed in the Pittsburgh dialogues) and *instructions* (7% of all the corrective responses) constitute two further classes of linguistic acts produced by teachers in the circumstances in which the student needs to be corrected. Just as questions, both assertions and commands can be characterised by different degrees of illocutionary and content specificity, although the variations are often less subtle than is the case with the interrogative forms.

In situations in which teachers need to correct their students, assertions typically manifest bipolar character with respect to the content and illocutionary specificity. On the one hand, there are examples such as 3.48 and its Polish equivalent 3.50, which are highly underspecified with respect to the content, but which leave no doubt with respect to the illocutionary force of the student's answer being rejected (in the Pittsburgh dialogues they constitute 27.3% of all negative assertions). On the other hand, there are assertions such as 3.52 which, although they leave nothing unsaid with respect to the content, they are relatively indirect with respect to the rejection of the student's answer being performed – these constitute a staggering 72.6% of all the negative assertions. Such frequent use of this type of negative assertion is quite surprising given their relatively uncompromising character. Although 3.52 is not *syntactically* negative, it is classified as a negative assertion on the basis of its implicature which in a student corrective context simply rejects the student's previous action as incorrect.

(3.48) **Teacher's corrective response:** No, that's incorrect.

(3.49)

(a) **Student's answer:** OK (*acknowledgement*)

(b) **Student's answer:** *Yes. (*decision*)

(c) **Student's answer:** Source. (*acknowledgement + content*)

(3.50) *Nie.*
No.
Teacher's corrective response: 'No [that's not right]'

(3.51) **Student's answer:** *silence.* (*acknowledgement*)

In comparison with the acts in 3.48 and 3.50, the acts in 3.52 and 3.54 seem much less polite in that they leave no option for a student to answer. On the other hand, despite being rather abrupt, the English example 3.48 leaves plenty of scope for the student to *riposte* it with either another content guess or with a defence of his prior answer, as well as giving the student the choice of not having to reply at all. Theoretically the same is true of the Polish example 3.50, but culturally determined factors may prevent the student from contradicting his teacher, or more likely – the classroom situation may not present the most suitable circumstances for defending an individual student's position.

(3.52) **Teacher's corrective response:** It is source that is needed to light a light bulb.

(3.53)

(a) **Student's answer:** OK (*acknowledgement*)

(b) **Student's answer:** *Yes. (*decision*)

(c) **Student's answer:** ?Source. (*acknowledgement*: *OK as a spoken response, strange as a typed response*)

(d) **Student's answer:** *Source. (*decision / content*)

(3.54) *Nie, anafora po prostu znaczy, że autor powtarza to samo*
No anaphora simply means that author repeats this same
słowo, albo frazę na początku każdego wersu.
word or phrase at beginning of each verse.
Teacher's corrective responses: 'No anaphora simply means that the author repeats the same word or phrase at the beginning of each verse.

(3.55) **Student's answer:** *silence.* (*acknowledgement*)

Apart from the extreme cases, teachers sometimes use more subtle assertions such as exemplified by 3.58 to which the context is provided by 3.56(a) and 3.57(b). Although there is no evidence of the same use of assertions in the Polish excerpts.

(3.56) **Teacher's initiation:** What is the range of voltage values you can expect?

(3.57) **Student's answer:** They will be under 10 volts. (*The correct answer: They will be 10 volts or less*).

(3.58) **Teacher's corrective response:** Good, they'll be 10 or less.

The student's answer in 3.57 is only partially correct and therefore the teacher needs to address the missing part of the student's knowledge. One way which would ensure an unambiguous information transfer would be for the teacher to tell the student that he was partially correct and to tell him the missing part of the answer sought. Instead, the teacher chooses a more discrete form of informing. Thus, despite 3.58 being highly content specific, in terms of its illocution it is very underspecified. Again it is by virtue of its subtle implicature that this type of act is classified as negative rather than based on its syntactic properties. While 3.58 seems to perform the function of a hidden negative, 3.48 seems not to be performed with the view of hiding the rejection at all. Finally, the communicative function of 3.52 is not immediately obvious, because despite of not rejecting a student's answer explicitly, it nevertheless carries a very strong implicature which suggests the main illocutionary force. As such, the example 3.52 should be perhaps classified as an extremely weak hidden negative.

Finally, teachers sometimes use instructions in response to student's incorrect actions. In the Pittsburgh dialogues, there are two types of syntactic forms used to express the instructions: the imperative forms illustrated in 3.59, which are also found in the Polish dialogues – example 3.61, and the interrogative forms shown in 3.63, which are not found at all in the Polish dialogues despite of such constructions being possible in general conversations. In both English cases and in the case of the Polish example 3.61, the fit responses are the same – either an acknowledgement or a covert acknowledgement and content.

(3.59) **Teacher's corrective response:** Try again!

(3.60)

(a) **Student's answer:** OK. (*acknowledgement*)

(b) **Student's answer:** * Yes. (*decision*)

(c) **Student's answer:** Source.(*acknowledgement + content*)

(3.61)	*Ktoś*	*inny?*	*Tomek?*
	Someone	different?	Tom?

Teacher's corrective response: '[Perhaps] someone else [can try]? Tom?'

(3.62)	*Elegia*	*jest*	*utworem*	*pisanym*	*na*	*cześć*	*umarłych.*
	Elegie	is	piece of literary work	written	on	honour	of dead people.

Student's answer: 'Elegie is a piece written in honour of dead people.' (*acknowledgement + content*)

(3.63) **Teacher's corrective response:** Why don't you try again?

(3.64)

(a) **Student's answer:** OK. (*acknowledgement*)

(b) **Student's answer:** * Yes. (*decision*)

(c) **Student's answer:** Source.(*acknowledgement + content*)

Both 3.59 and 3.63 are underspecified with respect to the answer sought and, at first glance, with respect to their illocution, i.e. in neither case does the teacher explicitly say that she believes the student's answer to be incorrect. Nevertheless the illocution is very prominent in both acts. This is because these acts constitute conventional indirect acts whereby their respective grammaticalisations and their semantic properties, at least in Western cultures, are conventionally linked with the rejection of a prior act (Fetzer, 2003). Although they are produced to the same effect, the instruction in 3.59 seems much less polite than the request in 3.63. The differences between the two forms are similar to the differences between the assertives in 3.48 and 3.52, in that 3.59 leaves no response options for the student and leads him directly to a specific action, while 3.63 is much less coercive in nature.

3.3 Taxonomy of Teachers' Corrective Responses

Based on the analysis of the linguistic responses that teachers tend to produce to student's erroneous answers, it is proposed that these responses be classified as shown in table 3.1.

In essence, the table constitutes a summary of the analysis presented thus far. The current classification draws from that proposed by Sinclair and Brazil mainly in that it uses the notions of initiation and of fit response. While in some cases the exact types of fit responses proposed by Sinclair and Brazil are used, other types are proposed to account for the slightly different semantic properties of acts which are produced in the educational circumstances in which teachers need to address a student's incorrect answer. Thus, a distinction is made between the informing initiations which are intended to provide the student with information as to the answer sought and those which are intended to inform the student about the fact that his previous answer to a teacher's questions was incorrect (in the table this is indicated by *inform of content* vs. *inform of reject* initiations). This distinction is at the heart of the current analysis and classification, because it refers directly to the illocutionary and to the content specificity, the different levels of which are manifested in the different syntactic forms used by teachers in corrective situations. Furthermore the different types of teachers' responses which were found in the dialogues studied are characterised by multiple, simultaneous

Type of Act	Surface Form	Initiation	Fit Response	Illocutionary Specificity	Content Specificity	Example
Negative Assertions 53.5%	Declaratives 27.3%	Inform of reject Seek Content and/or Defence	Acknowledge reject Content Defence of prior action	Very high	Very low	”That’s not right.”
	Declaratives 72.6% (Non-question Hidden Negatives)	Inform of reject Inform of content	Acknowledge reject Acknowledge content	High	Very high	“It’s the source that is needed.”
Instructions 7% Non-question Hidden Negatives	Imperatives 92.8%	Instruct Inform of reject	Action Acknowledge reject	Very high	Very low	”Try again.”
	Interrogatives 7.1%	Instruct Inform of reject	Action Acknowledge reject	High	Very Low	“Why don’t you try again?”
Hidden Negative Questions 39.3%	Interrogatives:					
	Positive Polarity 6.4%	Inform of reject Decision Inform of content	Acknowledge reject Decision Acknowledge Content	Very low	High	“Is heat needed to light a light bulb?”
	Negative polarity 6.4%	Inform of reject Decision/Agreement Inform of content	Acknowledge reject Decision/Agreement Acknowledge Content	Medium	Very high	“Isn’t it is power source that is needed to light a light bulb?”
	IF-THEN questions 24.3%	Inform of reject Inform of content Decision	Acknowledge reject Content Decision	Very low	Medium	“If you put the light bulb in the oven, it will certainly get a lot of heat, but will it light up?”
	WH-word Content-seeking 41%	Inform of reject Seek Content	Acknowledge reject Content	Very low	Low-Medium	“What formula do you have for calculating power?”
	WH-word Explanation-seeking 21.8%	Inform of reject Seek Explanation	Acknowledge reject Explanation	Low	Low-Medium	“Why would you say that?”

Table 3.1: Classification of teachers’ corrective responses.

initiations, which characterisation is supported by the fact that students often react to those responses by simultaneously giving different types of answers which correspond to the identified initiations. That these findings are plausible is confirmed by the fact that they are consistent for both sets of linguistic data analysed in this chapter. The fact that both the Pittsburgh and the Polish dialogues contain many comparable teacher responses to students erroneous answers also suggests that the notions of illocutionary and content specificity may be cross-culturally applicable to the type of educational contexts currently under investigation.

The linguistic variation observed in teachers' responses to student incorrect actions in both languages cannot be explained only by reference to the syntactic and semantic properties of the constructions used by teachers. The different levels of illocutionary and content specificity require a reference to the pragmatic factors such as the situational parameters which reflect the cultural and social information responsible for regulating the overall degree of indirectness of the acts produced. As was observed by Person *et al.* (1995), teachers' language is deeply embedded in the linguistic and socio-cultural conventions of given speech communities which operate on the outside of the educational settings. Those communities are responsible for establishing and maintaining certain rules of acceptable, polite behaviour, which rules are especially applicable in situations in which a person's goals may be perceived as threatening (e.g., Brown and Levinson (1987); Fetzer (2003)). A teacher's rejection of a student's incorrect action constitutes an example of such a threat. Teachers use their familiarity with the outside communities' principles of how to communicate such threats in order to maintain communication and cooperation between them and their students. Thus, teachers' language can only be explained and modelled with reference to their and their students' social and cultural context. The social and the cultural context seeps into the immediate situations in which individual sets of utterances are produced. Therefore, in order to model the nature of those utterances, and more importantly, in order to account for the processes which are involved in the specific types of linguistic acts being selected by teachers, it is necessary to view these acts in the context of particular situational parameters.

The current taxonomy, in particular the fact that (a) a single act can be used to perform many different communicative functions, and (b) that the overlapping sets of communicative functions can be expressed by quite different means leads to an observation which is crucial to the design of the current model – namely that the categories which refer to the linguistic means through which it is possible to express an illocution are of *non–discrete* nature.

The fact that a single linguistic act can be used to perform a multitude of different communicative functions is not limited only to teachers' corrective responses in educational language. Indeed many linguists observed the same multi-functionality of individual speech acts in other forms of language (e.g., Leech (1983); Verschueren (1985)). These observations impact on the type of categorisation which is ultimately adopted. The choice seems to be between the more traditional approaches to analysing speech acts, most prominently advocated by Searle (1969) and Searle (1979), in which speech acts are clearly assigned to discrete functional categories, and more recent approaches which are in line with the cognitive theories showing that generally human conceptualisation and categorisation happens in terms of cognitive continua, i.e., in terms of non-discrete categories (Rosch and Mervis (1975); Rosch (1977)). Based on the linguistic evidence presented in this chapter, the non-discreteness of speech act categories is taken in the current thesis as its underlying assumption which has an impact on the type of model presented here. As was discussed in Chapter 2 it is also a reason why the traditional methods used in Natural Language Generation are not employed here.

In the traditional, discrete view, Searle proposes five speech act categories such as assertives, directives, commissives, expressives and declarations. His taxonomy is based on a number of criteria such as "Differences in the point (or purpose) of the (type of) act", "Differences in the direction of fit between words and the world", etc. (Searle, 1979, pp.2-8). Since Searle's taxonomy was proposed many linguists have observed that it is inadequate in that a single illocution can belong to more than one speech act class (e.g., Vanparys (1996)). Leech (1983, p.207) demonstrates that "Advise, suggest, and tell, for example, can be either assertive or directive". And further Verschueren adds that the fact that the illocutions exemplified by Leech can be expressed by such different means makes them lack centrality to the category of directives (Verschueren, 1985, p.150).

The current analysis demonstrates that very similar sets of communicative functions can be expressed by different means. In that sense the types of speech acts presented in the taxonomy in table 3.1 are not mutually exclusive in the sense that a hidden negative can be expressed by means of an assertion as well as a questioning act. Furthermore, the analysis demonstrates that even within a speech act type, such as hidden negative questions, there exists a multitude of possible linguistic ways which can be used to express the goals. For example, the set: *inform of reject*, *elicit decision*, *inform of content*, can be expressed either as a positive polarity question or as an if-then question. The same set of the initiations overlaps with other types of acts such as negative assertives. The class membership of the individual speech acts seems more a matter of degree as discussed by Vanparys (1996) or Givón (1989) than a matter of absolute belonging. In the current thesis, as shown in table 3.1, the appropriate degrees of content and illocutionary specificity are seen as determining the degree of belonging of an act to a class. A more general discussion of the issues involved in classifying speech acts, their non-discrete nature and specifically with respect to the language found in the Pittsburgh dialogues can be found in Porayska-Pomsta *et al.* (2000a) included in the Appendix E.

3.4 Summary

This chapter presented the analysis of two sets of real educational dialogues. The focus of the analysis was on the teachers' responses to students' incorrect or partially correct actions. The analysis revealed significant linguistic variation in terms of the responses produced. This variation has been associated in the analysis with the changes in the levels of illocutionary and content specificity which, in turn, were said to cause the changes in the overall degree of indirectness of a given response. Since indirectness is generally linked with the notion of politeness and socio-cultural norms of particular speech communities, and since these norms are said to be reflected in the immediate situations of linguistic acts , it has been proposed here that in order to model the linguistic variation characteristic of teachers' corrective responses, it is necessary to understand the notion of the situational context and its contribution to the process of shaping teachers' linguistic decisions. Furthermore, the analysis revealed that the nature of speech acts produced in response to students' erroneous actions is non-discrete, which means not only that many communicative functions can be expressed in the same act, but also that the same, or closely overlapping, communicative functions can be expressed by different linguistic means. The fact that speech acts are non-discrete constitutes one of the basic assumptions on which the model developed in this thesis relies.

In the following chapter, an interpretation of situational context and of socio-cultural conventions as encapsulating certain rules of politeness, is presented. This interpretation is used to define the pre-requisites of a model of teachers' corrective response selection, which model outlines ways in which such selection may be automated.

Chapter 4

The Pre-requisites of the Model

4.1 Introduction

In the previous chapter the dialogue analysis has highlighted two main aspects of the language produced by teachers in response to students' incorrect or only partially correct actions:

1. There exists a great variety of the linguistic forms that may be used suitably as corrective responses in situations in which a student committed an incorrect or partially correct action.
2. The linguistic acts produced by teachers in such situations differ most prominently in terms of *content specifi city* and in terms of *illocutionary specifi city*.

In the discussion of the previous chapter it was also suggested, that teachers' linguistic choices are made according to a number of specific *contextual parameters* which, at any given point in an exchange, render a conversational act more or less appropriate. Furthermore, based on language analysis in socio-linguistics and ethnomethodology (Fetzer (2003), Goffman (1959), Brown and Levinson (1987), amongst others), it was established that the use of indirect language as caused by the presence and interaction between content and illocutionary specificity, may be the result of teachers abiding by certain rules of politeness which govern the behaviour of members of many speech communities.

In this chapter the discussion of Chapter 3 is taken as the basis for defining the pre-requisites of a model that mimics teachers' linguistic behaviour as observed in the dialogues studied. Specifically, three pre-requisites of such a model are defined here. In section 4.2, the notion of the *situational context* is defined in the educational linguistic domain as the first pre-requisite needed for the purpose of building such a model. A set of contextual parameters that may be relevant to deciding on the appropriate responses to students' incorrect and partially correct actions is proposed and the individual parameters are theoretically justified with respect to their applicability to the educational domain. The second pre-requisite, discussed in section 4.3, consists in a definition of Face, which concept has been identified in theoretical socio-linguistics as being responsible for linguistic variation in illocutionary specificity. It will be argued here that Face, if defined to capture certain particulars of teachers' language, can be also used to explain the variation in the levels of content specificity. The third pre-requisite which is closely related to the notion of Face consists in defining the role that communicative strategies play in situations where students need to be corrected by the teacher. This is done in section 4.4 in which the relevant assumptions on which part of the model developed in the current thesis builds are given. The main points made in this chapter are summarised in section 4.5.

4.2 Pre-requisite 1: the Situational Context

Situational context constitutes the first pre-requisite to the model currently developed. This is because following the claims by many linguists reviewed in Chapter 2 (e.g., Malinowski (1923); Heritage (1984); Germain (1979); Goodwin and Duranti (1992); Fetzer (2003)), context is the primary cause and the best explanation of linguistic variation. Since linguistic variation in the form of different ways in which a teacher may address a student's erroneous action is precisely the phenomenon that the current thesis attempts to account for, context seems also pertinent to such an account. Given the various theoretical claims discussed in Chapter 2, it is the assumption of this thesis, that an appropriate definition and a model of situational context may also facilitate the selection of various feedback moves by an intelligent tutoring agent in a way which reflects, to a degree, the process of selecting appropriate responses by human tutors.

In order to model situational context it is imperative to have a precise, working definition of it which explains what such context consists in and how it is structured. However, such a precise definition is very difficult to establish as is illustrated by the persisting lack of it in any consistent, universally usable form (e.g.Germain (1979); Goodwin and Duranti (1992); Clark (1996)). While finding such a universal definition does not constitute the objective of the current thesis, the proposals from various research on context are used to state a number of assumptions exploited in this thesis, and to formulate a *working* definition of it which may be suitable for the purpose of building the current model.

Thus, given the general discussion of the proposed interpretations of context presented in Chapter 2, in particular that by Austin (1962) and his felicity conditions, and Spencer-Oatey's (1992) interpretation of context in terms of variables relating to politeness, two general assumptions can be formulated regarding its nature:

Assumption 4.2.1 *Context is a multifaceted phenomenon which combines many different types of information relevant to a linguistic interaction.*

Assumption 4.2.2 *There are specific, identifiable contextual (or situational) conditions that must be satisfied either fully or at least partially at the time a linguistic act is produced for that act to be to any extent communicatively successful.*

Furthermore, following proposals such as that by Halliday (1962) and Spencer-Oatey's (1992) description of interactional context a first *working definition* can be formulated:

Working Definition 4.2.1 *Situational context of an utterance is a combination of non-linguistic facts which occur at the time the utterance is produced.*

The definition 4.2.1 is not a final one as it needs to be expanded by a further, formal specification of the notion of a "non-linguistic fact". Spencer-Oatey's informal list of such facts can be taken as an informal guide in identifying the non-linguistic facts which may be relevant to the educational situations in which teachers need to correct their students. Educational literature lends a hand with relating Spencer-Oatey's general variables to educational contexts. From now on the non-linguistic facts are referred to as *situational factors.*

4.2.1 Identifying the relevant situational factors

According to educational literature, there are many different situational factors which a teacher needs to consider when deciding on an appropriate way of addressing a given educational circumstance. Some of these factors are universal in all situations and are relevant to most of a teacher's decisions while the relevance of other factors varies from situation to situation. The two main types of information discussed in the literature and which a teacher needs in order to make an appropriate linguistic decision refer to:

1. Information regarding the material taught (interpreted in terms of Spencer-Oatey's *activity type* contextual aspect).

2. Information regarding the student who is being taught (interpreted as corresponding to Spencer-Oatey's *participant's characteristics.*).

Furthermore, the two dialogue sets introduced in Chapter 3, as well as the author's experience as a tutor, also point to a third type of contextual information which may play a role in teachers' decisions, namely the information regarding the temporal urgency typically associated with the amount of material needed to be covered in the face of the amount of time available. This type of contextual information is equivalent here to Spencer-Oatey's *setting.*

In the following subsections the factors which seem the most relevant to teachers' linguistic decisions are proposed. They are justified based both on the educational literature and on the evidence found in the two sets of dialogues. These factors will be validated further in the following chapters where the possible ways in which they interact with one another are also explored.

4.2.1.1 Temporal urgency

The effects of temporal urgency on a teacher's behaviour, let alone on her linguistic behaviour, is hardly ever mentioned in the educational literature. This is largely due to the emphasis that such literature understandably puts on identifying the aspects of teaching which result in an improved student learning. On the other hand, at its most extreme, temporal urgency may be perceived as having adverse effects on students' learning. This is because it may put both the teacher and the student under the pressure of having to complete a certain amount of material in specific amount of time regardless of other educational considerations. Yet, the dialogues introduced in Chapter 3 provide one with evidence that teachers do in fact take the temporal constraints into account when deciding on the appropriate responses to their students' erroneous actions. Most prominently teachers express their concern about the amount of time left explicitly as in the example 4.1. Temporal urgency, which, based on the author's experience and intuitions, is interpreted here primarily, as the effect of the interaction between the AMOUNT OF TIME available to a teacher and the AMOUNT OF MATERIAL needed to be covered in the available time, has been observed in the dialogues to affect the teacher's decisions in at least one type of situation, namely in cases where the student is persistently incorrect. A student who after several tries still cannot provide the teacher with a reasonable answer to her question or instruction adds to the urgency of a situation simply because the teacher cannot move on with the lesson. If the time is limited and the amount of material still needed to be covered is relatively large the teacher may be forced to give the answer away. Example 4.1 has been produced by the Pittsburgh tutor in one such situation.

(4.1) **Tutor:** We don't have much time left, so I'll tell you [the answer] *followed by an answer.*

Although there is no explicit evidence in the dialogues studied as to the amount of material left to cover playing a role in teachers' linguistic decisions (there is no such information included in the transcripts of the dialogues), the author's informal interviews with experienced teachers support the claim not only that teachers pay attention to the temporal aspects of a lesson, but also that they often regard the successful completion of a given set of material in the time specified as a way of teaching their students about time management and efficiency. In that sense temporal urgency refers to one of the educational goals and hence may not necessarily have adverse effects on learning after all. Temporal factors may not be overtly realised in all teachers' responses, but they may nevertheless affect the final form of the language produced, especially in the face of other factors such as the correctness of a student's answer and his overall ability. Typical effects may be found in teachers' responses by which they attempt to help the student, and thus speed up the process of him discovering the correct answer, more than in the situations in which the temporal factors may imply a lesser urgency. In such situations a teacher may use strong hinting in the form of providing the student with alternative answers, for example.

4.2.1.2 Characteristics of material taught

Apart from knowing the subject matter taught, in order for her tutoring to be effective, a teacher needs to possess an understanding of certain characteristics of the material taught. While numerous educationalists (e.g. Fox (1993); Person *et al.* (1995), Lepper and Chabay (1988)) consistently point at the DIFFICULTY of material as one such characteristic, the dialogues suggest that the IMPORTANCE of material may be another relevant factor in determining teachers' linguistic actions.

The educational dialogues in Chapter 3 indicate that a teacher's perception of the importance of a topic to a student's overall understanding of the subject may affect her linguistic decisions. Just as was the case with the lack of time vis à vis the amount of material left, there are explicit references made by the tutor in the Pittsburgh and by the teachers in the Polish dialogues to the importance of certain parts of the material taught. Of particular interest is the observation made in Chapter 3 regarding the possible relationship between the degree of content specificity of teachers' responses with respect to the answer sought from the student and the teacher's explicit acknowledgement of the importance of a current topic. Thus, in cases where the teacher remarks on the importance of a current task, she is more likely to respond in a more explicit and leading way than when she perceives the topic not to be as crucial (see example 4.2 and the equivalent Polish example 4.3). In such cases, a teacher is also more likely to persist with trying to get the student to act correctly for longer, i.e. over more conversational turns, than in cases where she seems to perceive the material as not so crucial[1]. There are also certain observable differences in the types of positive feedback given to the student's correct answer in situations in which the material is regarded as important and those in which it is not. In the first type of cases the teacher tends to be more enthusiastic and is likely to use stronger exclamatives and more superlatives (in the Pittsburgh dialogues: *Great!*, *Very good!*, in the Polish dialogues: *Bardzo dobrze* = *Very good*) than in the latter type of case (in the Pittsburgh dialogues: *Good*, *Right*, *OK*, in the Polish dialogues: *Tak* = *Yes*). The dialogues suggest a possible, strong relevance of the IMPORTANCE of material to teachers' linguistic decisions:

(4.2) **Tutor:** It's really important that you understand the answer to this question before you continue with the lab.

(4.3)

To	*jest*	*ważne*	*dla*	*zrozumienia*	*intencji*	*autora.*
This	is	important	for	understanding	intention	of author

Teacher: This is important for understanding the intentions of the author.

A teacher's appropriate recognition of the DIFFICULTY OF MATERIAL is a factor often cited as essential to the effectiveness of her teaching, and through that – as very relevant to her linguistic decisions. Difficulty is often referred to in the motivational literature as a factor against which a teacher ought to measure a student's overall ability and which ought to be adjusted appropriately in order to provide an adequate level of motivation for individual students (Lepper *et al.* (1993); de Vicente (2003)). One of the

[1]This is not observed in the Polish classroom. In such situations teachers tend to turn to a whole class or pick another pupil.

teachers' obligations, which is widely recognised by educationalists, is the obligation to guide the student in such a way as to prevent him from floundering and consequently to prevent him from becoming frustrated (Lepper and Chabay (1988); McArthur *et al.* (1990); Merrill *et al.* (1992); Fox (1991); Graesser *et al.* (1995)). The main source of students' frustrations has been often identified as resulting from an ill-adjusted level of difficulty relative to the student's abilities and his current performance (Lepper *et al.* (1993), Graesser *et al.* (1995); Person *et al.* (1995); de Vicente (2003)). These frustrations have been said to reflect negatively on other aspects relevant to learning. Lepper (1993), for instance, links the difficulty of material with the challenge which he claims to be necessary for motivating the student. He points out that an ill-adjusted level of difficulty may affect other aspects of student's motivation such as his self-esteem, his interest in learning and consequently that it may have devastating effects on the student's overall ability.

The dialogue analysis suggests that a teacher's awareness of the difficulty of a particular piece of the material taught coupled with her obligation to adjust the level of difficulty based on a particular student's needs, may be reflected in language that she produces. In cases where the student is having difficulties with the material, i.e. when he is obviously confused or starts guessing the answer, and hence where the current level of difficulty may be too high for him, the teacher tends to provide guidance usually in the form of very leading questions or in the form of very strong hints. Such leading questions and hints are often preceded by the teacher's direct or indirect acknowledgement of the fact that the student has difficulties with a particular aspect of a material (see examples in 4.4 and 4.5). Furthermore, the dialogues show that in such cases, the teacher is likely to give a lot of encouragement to the student in order to prevent the student from losing confidence in his ability. The difficulty of the material is therefore one of the most important situational factors recognised as crucial by numerous researchers in the domain of education and psychology and which factor can be observed in the dialogues studied to affect the teacher's linguistic responses.

(4.4)

(a) **Tutor:** It seems that you are getting confused, so let me help you. (*direct* *acknowledgement*) You already said that ....

(b) **Tutor:** Let's do it step by step. (*indirect acknowledgement*) What is the formula that you are working with?

(4.5)

(a)

No	*nieźle,*	*ale*	*czegoś*	*tu*	*jeszcze*	*brakuje.*	*Kto*
emphasiser-word	not bad,	but	something	here	still	missing.	Who

może	*pomóc*	*Pawłowi?*
can	help	Paweł?

Teacher: Not bad, but something is still missing here. Who can help Paweł?

(b)

No	*zastanówmy*	*się*	*nad*	*tym.*	*Dlaczego*	*pisząc*	*o*
emphasiser-word	let's think	self	above	this.	Why	writing	about

miłości	*do*	*tej*	*kobiety,*	*opisuje*	*ją*	*jako*	*martwą*	*istotę?*	*Coś*
love	to	this	woman,	describes	her	as	lifeless	being?	Something

tu	*jest*	*sprzeczne,*	*prawda?*	*Monika*	*co*	*ty*	*sądzisz?*
here	is	contradictory,	true?	Monika	what	you	judge?

Teacher: Well, let's think about this. While writing about his love to this woman, why does [the poet] decribe her as a lifeless being? Something is not right here. Monika what do you think?

4.2.1.3 Characteristics of the student

According to the literature (e.g., Lepper *et al.* (1993); Chi *et al.* (2001)) as well as to the informal interviews with several experienced teachers, a student's overall ABILITY vis à vis a particular subject matter and the CORRECTNESS of his latest action or answer constitute the primary situational factors which teachers take into account when designing their responses. These factors guide teachers' decisions and allow them to assess their student's individual needs. In the previous subsection it has been discussed that a student's ability is often used to adjust the level of difficulty, thus affecting the specificity in teachers' responses as well as potentially affecting a student's motivation. When coupled with a student's incorrect answer, a student's ability may have a determining effect on the form of a teacher's response. For example, it is possible to speculate that in case of an able student who gives an incorrect answer, a teacher may decide that an open-ended, explanation-seeking hidden negative is more appropriate than a highly leading hidden negative, which may be more appropriate for a less capable student who needs more guidance.

A student's correctness seems to be the direct trigger for the choices made. Depending on the level of correctness of a student's answer, the linguistic acts produced as a response to it may be of a completely different nature. A correct answer is likely to be met with a highly positive teacher feedback, such as a praise, while an incorrect action is often met with a negative feedback of a sort. The dialogues analysed show that the actual type of the negative feedback depends on other factors associated with the correctness of the student's answer, such as the number of attempts by the student to give an answer to the same question. Thus, the more attempts there are, the more explicitly negative a teacher's feedback tends to be and/or the more specific it tends to be with respect to the actual answer sought (see the examples from Pittsburgh dialogues in 4.6)[2].

(4.6)

(a) **Tutor:** No, the answer is ... (*after 4 incorrect attempts*)

(b) **Tutor:** Are you sure about that? Why don't you try plugging the value into the formula? (*after 1 incorrect attempt*)

The type of the negative feedback chosen by a teacher to a student's incorrect answer is also determined by certain motivational factors such as STUDENT'S CONFIDENCE and STUDENT'S INTEREST in the material taught. A student's level of confidence has been shown to be of primary importance to his overall motivation and successful learning (Lepper *et al.* (1993); Person *et al.* (1995)). Without confidence a student is often not capable of asking questions, of taking the initiative or even of paying attention. Lack of confidence may affect negatively the overall competence of an otherwise perfectly able student.

[2]This has not been observed in the Polish dialogues, which may be due to them occurring in the classroom settings.

The student's interest is another motivational factor often mentioned in the educational and motivational literature. Malone and Lepper (1987) and Lepper *et al.* (1993) associate it with their Challenge category of motivational facets of learning. As such then, interest seems inherently linked with the difficulty of the material and hence with the specificity of a teacher's language vis à vis the answers sought (content specificity). Although a student's lack of interest may be the result of the material being either too challenging or not challenging enough, it may also be the direct result of a student's lack of confidence. A competent tutor must be able to distinguish between the possible sources of a student's lack of interest and she must be able to adjust her language appropriately.

The dialogues shed light on the way in which teachers may be affected by these two factors in their linguistic decisions [3]. Specifically, while it seems that the less confident the student is the more indirect and encouraging the teacher's language becomes (examples in 4.7, 4.8 and 4.9, 4.10), the more disinterested the student is the more direct and disapproving the negative feedback appears to be (examples in 4.11, 4.12 and 4.13, 4.14). However a combination of the two may result in a fairly encouraging feedback in which the teacher also tries to be as positive as possible (example 4.15 and 4.16).

(4.7) **Tutor:** You're on the right track.

(4.8) **Tutor:** Well, if you put the light bulb in the oven it will certainly get a lot of heat, but will it light up?

(4.9) *Ciepło.*
Warm.
Teacher: Warm (as in: You're getting closer).

[3] Again, the evidence is tentative, because the transcripts of the dialogues neither provide one with the information regarding the students' motivational states or with clues which could be used to infer such sates, e.g., students' hesitation, their facial expressions, etc.

(4.10) *No dobrze, ale czy poeta rzeczywiście*
emphasiser-word well, but question-wors poet really
nienawidzi swojej ukochanej?
hates his beloved?
Teacher: Well OK, but is it really the case that the poet hates his beloved one?

(4.11) **Tutor:** No, that's still not right. Try again.

(4.12) **Tutor:** You should connect the red lead to the positive side of the circuit and the black lead to the negative side. Go ahead and do it.

(4.13) *Nie, to jeszcze nie tak. Ktoś inny proszę. Ania.*
No, this still not this way. Somebody else please. Ania.
Teacher: No, this isn't still right. Somebody else please. Ania [you try].

(4.14) *Nie, elegia jest utworem pisanym do umarłch. To już*
No, elegie is piece of work written to dead. This already
ustaliliśmy.
we established.
Teacher: No, elegie is a piece of literary work written to honour the dead. We established this already.

(4.15) **Tutor:** Good try, but that's still not right. Why don't you try again?

(4.16) *Nie zupełnie. Ktoś inny może?*
Not quite. Someone else perhaps?
Teacher: Not quite. Perhaps somebody else [will try to answer]?

4.2.2 The eight situational factors-value pairs

In the previous subsection, eight situational factors were identified as potentially relevant to teachers' linguistic decisions. In the above discussion, for each of those factors informal references were made to the possible values that they may take. For

Table 4.1: The set of eight situational factors relevant to teacher's linguistic decisions and their possible values

Factor Name	**Possible Values**
1. Amount of time available:	plenty very little
2. Amount of material left:	little lots
3. Difficulty of material:	difficult easy
4. Importance of material:	crucial not crucial
5. Student's Ability:	high low
6. Correctness of student's answer:	incorrect partially correct
7. Student's confidence:	confident not confident
8. Student's interest:	interested not interested

example, the amount of time left may be *very little*, student's confidence may be *low* and the difficulty of the material taught may be *difficult*. In order to finalise the working definition of situational context which will be used to build the current model, it is necessary to specify the exact possible values that each factor may have. Because the model presented in this dissertation is intended as a prototype of an exploratory nature with a potential of being extended at a later stage, the number of values that each factor is currently allowed to have is exactly two. The values are binary and mutually exclusive. For example, the factor STUDENT'S CONFIDENCE can only take values *confident* or *not confident*, the factor DIFFICULTY OF MATERIAL can either have the values *easy* or *difficult*, etc. Obviously this is a simplification of the situational factors which in reality may be of a more continuous nature. It is possible to argue that a model based on factors which are allowed to take only binary values, not only lacks in cognitive plausibility, but may be too simplistic to produce useful results. However, the results of the evaluation discussed in Chapter 8 do not support this argument. The current model of which the decisions are based on the simplified definition of situational factors still manages to produce rich linguistic output which is in line with the linguistic behaviour of human tutors, while allowing for the complexity of the relevant data collection (presented in Chapter 5) and of the initial model (Chapter 6) to be reduced. The final working definition of situational context used in this dissertation is formulated as follows:

Definition 4.2.1 *Situational context of an utterance is a combination of eight situational factor-value pairs which occur at the time the utterance is produced.*

The complete set of situational factors proposed in this thesis as relevant to teachers' linguistic decisions is given in table 4.1. By no means do the factors include all of the types of information mentioned in the literature as relevant. For example, some of the motivational factors, such as student's Satisfaction discussed by Lepper and Chabay (1988) are omitted here. However they do represent those factors mentioned in the literature for which there is certain evidence in the dialogues studied and of some of which relevance was confirmed by the author's informal interviews with a number of experienced teachers. Table 4.1 also lists the set of the possible values that are assumed in the current model for each of the factors. At a time a teacher makes a linguistic decision, a factor may have one of the two possible values associated with it. Although, the factors are proposed based on research in education, educational psychology, as well as on the two sets of dialogues introduced in Chapter 3, they nevertheless represent the current author's and other researchers' assumptions and intuitions. To render them a more trustworthy basis for the model developed here they have been empirically investigated in the study presented in Chapter 5.

4.3 Pre-requisite 2: the Definition of *Face*

Face is considered to be the second pre-requisite necessary to build the model of teachers selecting linguistic responses to student's erroneous actions. This is because in theoretical linguistics Face is considered to be the central notion in the analysis and explanation of linguistic politeness (most prominently Brown and Levinson (1987)). In turn, linguistic politeness is often identified as being responsible for a great deal of linguistic variation in language (Fetzer, 2003). In Chapter 3 politeness was also linked to the linguistic variation which characterises teachers' responses to students' erroneous actions. It seems, then, that in order to model the processes involved in teachers selecting such responses, an examination of the notion of *Face* in the educational context, and a definition of it which is relevant to education, is essential to the model.

In Chapter 2 a detailed review of Brown and Levinson's approach to analysing linguistic politeness was given. Their definition of Face was said to depend on two socio-psychological dimensions, namely on Approval (Positive Face) and on Autonomy (Negative Face). These two dimensions were linked by Brown and Levinson directly to the communicative strategies and to concrete linguistic choices available to speakers in general conversations. The appropriateness of those choices in given situations was said to depend on the calculation of the Face Threat posed by a given act based on language external variables of Power, Distance and Rank of imposition. A great deal of discussion was dedicated in Chapter 2 to explaining the problematic aspects of the variables as related to linguistic indirectness and of the calculation of the Face Threat.

This section discusses the applicability of Brown and Levinson's approach to the situations in which students need to be corrected and it provides a definition of Face which accommodates the characteristics of educational talk. An examination of the role of social variables proposed by Brown and Levinson is conducted in the context of corrective responses, and based on the conclusions of this examination, a definition of Face for the educational contexts under investigation here is provided. The definition of Face is a way in which to characterise both the output of the situational part of the model presented in Chapter 6 and of classifying the linguistic responses produced by teachers to students' erroneous actions in a way which facilitates the mapping between the responses and individual situations.

4.3.1 The status of Brown and Levinson's social variables in education

Brown and Levinson claim the relevance of the three social variables of distance (D), power (P) and rank of imposition (Rx) (introduced in Chapter 2) to the linguistic choices that speakers make across various cultures. This is a plausible claim which received a lot of interest and support from many linguists over the years (e.g., Blum-Kulka *et al.* (1989); Spencer-Oatey (1992)). However, Brown and Levinson's explanation of the ways in which speakers' utterances depend on the three variables is rather vague and poses problems with respect to the process of teachers selecting the appropriate responses to students' erroneous actions being modelled formally. For example, when presented with an utterance classified as belonging to one of Brown and Levinson's strategies, it is not clear how one would determine which of the three variables actually contributed to the given classification and to what extent. Furthermore, Brown and Levinson suggest that the variable W_x which represents the sum of the values of the three social variables is always needed in choosing the appropriate FTA strategy. However they do not take into account the fact that linguistic patterns may differ not only cross-culturally, but also within a specific domain of discourse.

In general the linguistic patterns are dependent on the conventions which are specific to a particular speech community (Fetzer (2003)). The conventions on which teachers rely in designing their responses are different from those used in more general social contexts. Thus, in circumstances other than the educational ones, all three variables may indeed play a crucial role in determining the form of language, because they may lead to important gains (or losses) for the persons involved. For example in a boss-employee relationship it may be the case that explicit acknowledging by the employee of the boss' higher power and the distance between them may be a way of "tickling" the latter's positive (superior) self-image and a means for the employee to be promoted, for instance. In such circumstances, when making a request the employee is likely to minimise the rank of imposition of his request by designing his language appropriately.

However, in education, especially in the western, Anglo-American culture, there is a different tendency regarding the social variables. In particular, the role of the Power and the Distance variables seems different in teacher-student relationships than is suggested by Brown and Levinson to be the case in normal interactions. By default a teacher has more power than the student, which is an accepted facet of education specified in the conversational contract between a teacher and a student. Because of this, power often ceases to be an issue in standard, non-disciplinary exchanges between a student and a teacher and therefore it is often not manifested in the language produced by teachers, by virtue of being held relatively constant. This is particularly the case in situations in which a teacher needs to correct the student. The informal interviews with experienced teachers and tutors suggest that in such situations the teachers are even more aware of the damaging consequences that their exploiting their higher power over students may have on student's progress.

Also, the recognition of the distance between teacher and the student is not manifested in teachers' language produced in situations investigated here. Again it seems generally accepted by both parties involved in an educational interaction that in non peer-to-peer exchanges the teacher is older, more knowledgeable and more experienced - again this is specified in the conversational contract between the two parties. There is no need to exploit the distance because there is no need to reassert this accepted fact. Just as the P variable, the D variable seems to be relatively constant. This is confirmed very strongly by the interviews with teachers and tutors and by the results of the statistical analysis (presented in Chapter 5 in which study the importance of the D variable (presented to the teachers under the name *formality*) to teachers linguistic decisions was tested. In their reports the teachers were adamant that formality was not an issue at all in their teaching experience.

On the other hand, an explicit exploitation of Power and Distance could have some undesirable effects on students' learning. The realisation of his relative lack of power, by virtue of the teacher's higher power being made explicit, could impinge on the student's initiative, while distance could affect his confidence: the student could find the lack of similarity (social as well as meritorical) between him and his mentor intimidating. Informed by several teachers' informal comments the assumption here is that in standard educational circumstances, a good teacher would ignore these variables to avoid the possible negative effects on student's progress. This further supports the suggestion that P and D are not exploited by teachers in situations under consideration here. While no experimental studies in the vein of those cited in Chapter 2 were conducted to test these assumptions, an examination of the Pittsburgh interactions and the comparison between those and the Polish dialogues suggest that while in the Pittsburgh dialogues P and D may be both relatively low, in the Polish exchanges they have slightly higher values. Nonetheless these values seem to remain constant in both types of exchanges. In turn, this suggests that the only social variable actively exploited by teachers in the circumstances in which they need to produce a corrective response is the variable R_x, which makes the calculation of W_x redundant here. The emphasis of educational situations on facilitating students' knowledge acquisition which, in turn, leads to P and D being interpreted as not influencing teachers' language as they are claimed to do in normal conversations, suggests that Brown and Levinson's R_x is the only variable which may explain the linguistic variation in teachers' responses to students' erroneous actions. It is the assessment of R_x vis à vis the threat to students' Face that explains most effectively the different linguistic choices made by teachers. Brown and Levinson's R_x is interpreted in this thesis in terms of the amount of Autonomy and the amount of Approval offered to (or taken away from) a student by a teacher, while Brown and Levinson's variables P and D are not included at all in the current model of teacher's language use.

4.3.2 Autonomy and Approval: the dimensions of Face in the educational domain

Although Brown and Levinson's theory of politeness is very inspiring with respect to the analysis of teachers' linguistic decisions, as was discussed in detail in Chapter 2, it has also certain shortfalls. Since the theory has been designed to account for all of the language in a cross-cultural manner, it is not always fine-grained enough to account for the relevant aspects of language on the linguistic sub-domain levels. To remedy this, the notion of Face needs to be defined to suit the educational linguistic sub-domain, with a particular emphasis on the type of situational context in which student-corrective actions are required from a teacher. In this sub-section, the two dimensions which are proposed in the current thesis to characterise the notion of Face are re-interpreted specifically for the situational contexts in which students need to be corrected by a teacher.

The current definitions of the Face dimensions rely on three assumptions:

Assumption 4.3.1 *Only the student's Face is ever affected.*

Assumption 4.3.2 *Face can be indeed characterised in terms of the students' need for Approval and Autonomy (referred to by Brown and Levinson as Positive and Negative Face respectively).*

Assumption 4.3.3 *The linguistic strategies available to a teacher can be interpreted in terms of the two dimensions of Approval and Autonomy.*

Note that the assumption 4.3.1 is a simplification of Brown and Levinson's proposal in which the respective Faces of all the participants in an interaction are affected.

In that sense the corrective responses which the current model can recommend are those of an altruistic teacher. In reality it is not the case that teachers ignore their own Face needs and wants, as analyses of educational interactions such as that by Person *et al.* (1995) can be used to exemplify. While this simplification is made to reduce the complexity of the initial model developed here, it is also motivated by two observations. First, given the dialogue analysis it seems that while a teacher's Face may affect the language that she produces in general educational circumstances, in situations in which she needs to take student-corrective action the student's cognitive and emotional needs seem to play the most important part in teachers' decisions. This interpretation is also confirmed by the comments made by the teachers participating in the study presented and discussed in Chapter 5. Second, the decision to define Face in the current model as referring only to the student's needs and wants is motivated by the considerations expressed in Chapter 1 on page 8, which considerations concern the nature of human-computer interactions and full applicability of linguistic theories as accounts of such interactions. It is not clear at this point whether or not an automated tutor should manifest exactly the same characteristics as its human counterparts and thus, whether a more self-centred tutoring agent equipped with Face would be indeed beneficial to students' learning.

4.3.2.1 Approval

Definition 4.3.1 *Approval. Approval is a dimension of a student's Face which refers to the student's need for his positive self-image to be maintained.*

Definition 4.3.2 *A student's positive self-image. A student's positive self-image relies on his confidence and interest being maintained or boosted.*

Thus, in the context of the situations considered in this thesis, the manifestation of a teacher's Approval is assumed to be done by means of a teacher maintaining or boosting a student's confidence and/or his interest in the lesson through providing the student with positive feedback.

It could be argued that student's interest is not a facet of Face. However, a teacher making an extra effort to keep a student interested in the material taught can be interpreted as approving of the student, particularly if the student is progressing slowly or has provided an incorrect answer to the teacher's previous question. The general intuition here is that an interested student may be more confident in learning, while boredom may be a sign of lack of confidence. The link between the student's confidence and the student's interest has also been made in the context of student motivation which has been said to be affected, amongst other factors not considered in the current thesis, by these two factors (Malone and Lepper (1987); Lepper *et al.* (1993); de Vicente (2003)).

Although the Approval dimension of a student's Face is his need and want to be given positive feedback, it does not mean that such feedback ought to be, or is, given to him at all times. In fact, this aspect of a student's Face can be addressed in several cases and in two different directions:

1. If a student shows signs of lack of confidence especially when his progress is slow, this may require a positive address of Face.
2. If a student shows signs of being over-confident, especially when his progress is slow, this may require a negative address of Face.
3. If a student is persistently and/or ostentatiously disinterested in constructive participation in a tutorial, this may require his Face to be addressed negatively.
4. If a student shows signs of relative confidence and interest, this may suggest to the teacher that no explicit address of Face is an affordable option.

Note that *positive address* means giving Approval, while *negative address* means either not giving Approval or explicitly disapproving.

In general the more explicit the references to a student's good traits, his prior or current achievements or the correctness of his answer, the more Approval is given to the student. Also if an act supports the student's reasoning without giving away too much of the answer, the act can be judged as expressing Approval. In such a case if a teacher merely presents a hypothesis in the form of association clues, say, then this expresses more Approval than if a teacher expresses doubt by implication using a queclarative e.g. *Isn't the wire already in the circuit?* Thus, clearly, Approval affects both the level of illocutionary specificity (*Isn't the wire already in the circuit?* vs. *No, the wire is already in the circuit*), and the level of content specificity (*Isn't the wire already in the circuit?* vs. *What would happen if you did X?*, where the assumption is that doing X would make the student realise that the wire is already in the circuit).

4.3.2.2 Autonomy

Definition 4.3.3 *Autonomy. Autonomy is a dimension of a student's Face which refers to his need to be allowed the freedom of initiative to discover the knowledge by himself.*

Just as was the case with Approval, the need for Autonomy can be addressed either positively or negatively. In other words, the need to be given initiative may or may not be fulfilled by a teacher depending on the circumstances. There are at least two possible scenarios in which a teacher may address a student's need for Autonomy negatively:

1. The teacher is running out of time.

2. The student's progress is persistently slow.

Otherwise the default scenario adopted in this model is that a teacher wants to give her student as much initiative as possible.

The process of discovering knowledge also includes the discovery of one's own misconceptions and ignorance. The extent to which a teacher can respect a student's need for Autonomy depends on the student's overall progress, a given teacher's methodology, and her own personality and social attitudes. Having said that, a general rule of thumb is assumed here: the *less information* regarding the answer sought a teacher gives to her student the *more Autonomy* she is considered to give to the student and *vice versa*. Generally, the benefits of putting the learning initiative in the student's hands (typically associated with Socratic dialogues and tutoring) has been found to be potentially beneficial to students' learning (e.g., Chi *et al.* (2001)). In the current model a teacher will tend to choose strategies which lead to such a benefit before considering any other possible strategies. Thus Autonomy is primarily concerned with content specificity. However, just as was explained to be the case with Approval, the level of Autonomy expressed in an utterance may also affect the level of illocutionary specificity.

4.4 Pre-requisite 3: The Nature of Strategies in the Educational Domain

Linguistic variation has been associated with social conventions characteristic of a given speech community (e.g., Brown and Levinson (1987); Fetzer (2003)). The social conventions are manifested in the communicative strategies which define the appropriate use of specific linguistic forms to particular social situations. Since educational situations are an example of such social situations, it seems necessary to explore the concept of communicative strategies with respect to the requirements of educational circumstances. The results of this exploration, presented in the form of the assumptions about the aspects of social behaviour that the strategies ought to reflect to account for teachers' language, constitute the third pre-requisite to the current model.

Brown and Levinson refer to the communicative strategies as the strategies for doing Face Threatening Actions, or simply as FTA strategies. Their definitions of FTA strategies are designed to capture one of language universals, namely that of linguistic politeness. Although this is a very useful approach, their proposal is too general to account for language which occurs on linguistic sub-domain levels such as the educational domain. Within the educational sub-domain some of the strategies proposed by Brown and Levinson simply do not apply to teachers' language (for example, teachers do not tend to offer gifts to students as a way of fulfilling their needs; Brown and Levinson's strategy 2.15) and those strategies that do apply often require a more detailed specification or a complete re-definition. Furthermore, Brown and Levinson's strategies fail to account for certain linguistic phenomena which, intuitively, a politeness theory ought to be able to explain. For instance Thomas (1995) points out that Brown and Levinson's model does not include strategies for acts in which speakers are intentionally face threatening, because it assumes that S would never want to be intentionally or explicitly rude to H. Social and linguistic evidence as well as simply everyday experience suggests otherwise: people are often intentionally rude (or bald) to each other and do not make or try to make a secret out of it as is shown in Thomas' examples reproduced in 4.17, 4.18 and 4.19 (Thomas, 1995, p.171).

(4.17) *Bob Champion, champion jockey, referring to women jockeys:*

I'm dead against them! They're a mistake and get in the way. Women are not strong enough or big enough.

(4.18) *Mr Tam Dalyell, M.P., in the British House of Commons referring to the then Prime Minister, Margaret Thatcher:*

I say that she is a bounder, a liar, a deceiver, a crook.

(4.19) *Australian Judge in the court case brought by the British Government to try to prevent the publication of the memoirs of Peter Wright, an ex-member of MI5. The judge is referring to the evidence given by the then British Cabinet Secretary, Sir Robert Armstrong:*

His evidence is palpably false and utter humbug.

Just as in the case of Brown and Levinson's model, the notion of strategy for doing FTAs in educational context relies on the assumption that participants in an interaction have the capability for rational reasoning from ends to means, and that a strategy represents a precisely defined set of means by which to achieve those ends.

Brown and Levinson's strategic system for performing FTAs is essentially sound and serves as a reliable guide to developing a similar system for teachers' linguistic choices. Thus their basic five strategies are used here to define a system of strategies for doing FTAs and which is presented in Chapter 6.

Although Brown and Levinson's high level strategies are adopted here to represent the communicative conventions of teachers' speech community which functions on the outside of the educational context, at the lower levels the functions of those strategies are redefined in accordance with the demands of the educational context currently under investigation, namely the context in which a teacher is required to undertake corrective actions in response to a student's incorrect or partially correct answers to previous questions. Also, the strategies are redefined in agreement with the criticisms presented here of Brown and Levinson's assumptions on which their model is based. These assumptions include the following:

BL's Assumption 1 *Strategies for doing FTAs are designed to avoid threat to participants' respective Faces.*

BL's Assumption 2 *The participants never want to be intentionally or explicitly rude (or bald) to each other.*

BL's Assumption 3 *Not all linguistic actions are Face threatening.*

These assumptions are in conflict not only with the current author's intuitions regarding the linguistic data observed in the Polish and Pittsburgh dialogues, but also with the analysis of non-educational linguistic data carried out by other researchers such as Thomas (1995) and Dascal (1977). In particular, Dascal's view that any action, linguistic or not, on the part of participants of an exchange is potentially threatening to their Faces, rings true in the educational context in which a teachers' task is to correct a student and if adopted, it has certain important implications for the applicability of Brown and Levinson's account as is. While Brown and Levinson consider only the positive side of politeness, to account more fully for linguistic actions made with respect to Face, the negative side of politeness (or simply impoliteness) needs to be considered as well. Person *et al.* (1995) confirm that the working assumptions of Brown and Levinson are problematic in educational situations and that there are many circumstances in which a teacher may be bald when correcting a student in order to achieve the desired educational goals. This means that the relative simplicity of Brown and Levinson's strategic system, where lower-numbered strategies were chosen if the threat was assessed as minimal, and conversely higher-numbered strategies were chosen given high level of threat, is compromised. This point is elaborated in detail in Chapter 6.

The assumptions which form the basis for the system of strategies for performing Face Threatening Actions in educational situations under investigation here stand in an opposition to the assumptions on which Brown and Levinson's model is based:

Assumption 4.4.1 *Strategies for doing FTAs ought to reflect the intentions both to be polite and to be impolite (or to be bald even if the act is assessed as maximally Face Threatening).*

Assumption 4.4.2 *Teachers are intentionally both polite and sometimes regrettably impolite (or bald).*

Assumption 4.4.3 *All acts are potentially Face Threatening.*

In Chapter 6, these assumptions lead to a drastic re-interpretation of Brown and Levinson's five basic strategic categories. The system of strategies that is presented in Chapter 6 incorporates the intuitions that both the polite and impolite qualities of language are exploited not only in everyday conversations, but also in educational interactions.

The system of strategies suitable to characterise the linguistic responses made by teachers in the educational circumstances in question here are considered in the current thesis a useful way of analysing the linguistic possibilities available to teachers. However, as will be explained in Chapter 6, the model developed in this dissertation does not involve the teacher explicitly reasoning about, or choosing the strategies. Instead, utterances are chosen directly on the basis of the recommendations with respect to the suitable levels of Autonomy and Approval from the situational part of the model.

4.5 Summary

In this chapter three pre-requisites to a model of teacher's selecting responses to students erroneous answers were defined. Because the central problem to modelling such a selection concerns the enormous variety of linguistic possibilities available to teachers, and since linguistic variety has been said to depend on context, a concrete definition of situational context was said to be one of the three pre-requisites needed. The situational context was defined as a combination of eight factor-value pairs and the relevance of each of the eight factors was established on the basis of the educational literature, the dialogues analysis, as well as the current author's intuitions and experience as a student and a tutor.

Because linguistic variation has been strongly associated within socio-linguistic research with the notion of politeness, a formal definition of Face, which is said in the linguistic literature to constitute the central aspect of linguistic politeness, was identified as the second pre-requisite needed. Its definition in the context of education was adapted from the proposal by Brown and Levinson (1987). Two dimensions of Face were defined, namely the Autonomy and the Approval dimensions.

Because linguistic variation is also associated with social conventions which are manifested in the communicative strategies of a given speech community, the expected nature of such strategies as applicable in educational domain was determined as the third pre-requisite to the model. Again, Brown and Levinson's proposal was used as the starting point.

In the following chapter, the interaction between the eight situational factors and their values is investigated by means of a study carried out amongst experienced teachers. The study is used partly to validate the choice of the eight factors further, but primarily it is used to inform the design of the model with respect to the ways in which the factors are correlated. Chapter 6 presents the entire model of teachers selecting responses to students' erroneous actions. The model includes a system of strategies which is used to assign Autonomy and Approval values to teachers' individual corrective responses.

Chapter 5

An Exploratory Study with Teachers

5.1 Introduction

In chapters 3 and 4, specific assumptions are made regarding a possible way in which to model the type of linguistic data found in the Pittsburgh and the Polish dialogues. Inspired by the relevant research in the role of context in language production reviewed in Chapter 2, the linguistic data analysis in Chapter 3 highlighted the notion of *situational context* as a way of determining the appropriate interpretation of linguistic acts in terms of their communicative, functional categories. In Chapter 4, situational context is given a general working definition which states that *situational context of an utterance is a combination of eight situational factor-value pairs which occur at the time the utterance is produced* (see Chapter 4, section 4.2.2, page 120).

Specifically to the educational domain, eight situational factors have been proposed based both on the relevant literature reviewed in chapters 2 and 4 as well as on the current author's own intuitions and experience as a tutor and a student. In order to bring the various theoretical discussions closer to the real world, a study has been designed to validate the factors further and more crucially to explore the interaction between the various factors for the purpose of informing the design of the situational part of the model presented in Chapter 6. Given that the primary concern of the current thesis is with the educational domain of discourse, the study sets out to test teachers' perception of situational contexts specifically in one-to-one exchanges which require teachers to produce corrective responses.

The purpose of this chapter is to describe the study, to analyse it and to discuss its results in the face of the assumptions of the previous chapters. The chapter is organised as follows. Section 5.2 states the purpose of the study and it restates all the relevant assumptions made in the previous chapters in the form of questions which the study is used to address. Section 5.3 describes the design of the study along with the statistical tests used in answering each question. In section 5.4 the results of the study analysis are presented, which are then discussed in section 5.5.

5.2 The Purpose of the Study

The main purpose of the study is to answer three questions regarding the nature of situational context in relation to teachers' linguistic decisions in the educational domain of discourse. In turn, the answers to those questions are to provide an empirical basis for various parts of the model presented in Chapter 6. There are two types of assumptions stated in chapters 3 and 4, which provide a general, theoretical basis for the three questions.

The first type refers to the assumptions made predominantly by a number of researchers in the areas of linguistics and philosophy of language. These assumptions state that **(a)** on a general, functional level, language can be analysed in an informed way only in the context in which it has been produced (e.g., Thomas (1995)), that **(b)** on a specific, functional level, language needs to be examined based on situationally sensitive categories (e.g., Spencer-Oatey (1992)), and that **(c)** it makes sense to describe situational context in terms of individual situational factors which cumulatively impact on speakers' linguistic decisions (e.g., Givón (1989); Spencer-Oatey (1992)). Given the relevant literature reviewed in Chapter 2 and the discussion in Chapter 4 both concerned with justifying these assumptions, in the current thesis they are not tested explicitly.

The second type of assumptions refers to the author's own intuitions, which are based on experience as both a student and a tutor. The specific assumptions are also based on the relevant linguistic and educational literature (e.g., Lepper and Chabay (1988); Lepper *et al.* (1993); de Vicente (2003)), in which certain factors are proposed as relevant to specific aspects of educational situational contexts. In Chapter 4, eight such situational factors have been proposed (see table 4.1), and thus, the questions which the current study is set to address concern primarily those eight factors. However, the study tests two additional situational factors, namely the FORMALITY of the rapport between the student and the teacher, and the STUDENT'S SENSE OF HUMOUR. The formality is tested in order to support further the decision as to not to include Brown and Levinson's social variable of *distance*[1] in the model's estimation of Autonomy and Approval. On the other hand, the inclusion of the sense of humour is the result of the author's informal interviews with various teachers prior to the study being designed, in which they claimed the importance of this factor to their decisions.

The study attempts to answer the following three questions:

Question 1 *Do experienced teachers perceive the eight factors as relevant to educational contexts in which students need to be corrected?*

Question 2 *Are the eight factors equally relevant to all teachers' decisions in all situations?*

Question 3 *What are the relationships between different factors?*

The reason for asking the first question is simply to validate the eight factors. If teachers participating in the study can be shown to recognise a factor as relevant to their decisions then such a factor can be said to be validated by the study.

The second question becomes possible only when the situational factors presented to the teachers are validated by them. It is a complex question which leads to at least

[1]The power variable is not investigated in the current study formally, because it was diffi cult to see a natural way in which to fi t it in the descriptions of the situations presented to the teachers. In order to test for this variable a study in the vein of those discussed in Chapter 2 seems more appropriate.

two sub-issues. The first issue refers to the importance of each factor to teachers' linguistic decisions and is based on an assumption inspired by research on short-term memory and attention (e.g., Baddeley (1990)) which suggests that in complex situations people can focus on, or recall, only their most prominent aspects. In the current thesis, this is taken to imply that not all the situational factors have the same impact on teachers' decisions at all times, and consequently that the linguistic variety which characterises teachers' language may be explained by the varying importance of situational factors. If in given situations teachers can identify the more important factors *versus* the less important ones, then the first step is taken towards supporting the assumption that teachers prioritise the situational information available to them and that such prioritising is reflected in the language that they produce.

The second question is strongly related to the first one: if teachers can observe the more and the less salient factors in given situations, then are these observations the same for all teachers, or do they vary from teacher to teacher? For example, are there some factors (and their possible values) which are perceived universally, i.e. by all the participating teachers, as important while others have always weaker impact on their decisions, or is there no evidence of such universal perception? The question is particularly relevant to the way in which the overall strength of the contributions to teachers decisions by individual factors is modelled in the situational component of the model (see Chapter 6 for details regarding the situational component). The overall strength of a contribution by a factor constitutes additional information about a factor to the information about its importance in a specific situation. For example, in a given situation, the contribution by the factor STUDENT'S CONFIDENCE with the value *confident* may be more or less significant relative to other factor-values in the situation, depending on whether or not the confidence factor is perceived by teachers as universally more or less important than other factor-values.

The last question is motivated by certain groupings of factors that were proposed by researchers such as Lepper and Chabay (1988) (specifically the grouping of STUDENT'S CONFIDENCE and the STUDENT'S INTEREST), and those which were the result of the author's common-sense expectations such as the expectation that the

AMOUNT OF TIME LEFT and the AMOUNT OF MATERIAL LEFT should be clustered together. As was explained in Chapter 4, the current working assumption is that there are different types of situational factors referring to different aspects of an educational situation. These factors also contribute in different ways to teachers' linguistic decisions. For example some factors may predominantly affect the amount of Autonomy that a teacher gives to her student, while other factors may be influencing the amount of Approval that she offers to her student. If relations between the individual factors can be found in the current study, then the intuitions expressed in Chapter 4 regarding the particular groupings can be confirmed and the nature of their contributions may be guessed in a more informed way. Furthermore, such an analysis may prove informative with respect to other possible groupings of factors which are not considered in the literature to date, and ultimately it may inform the design of the model developed here.

5.3 The Design of the Study

The study has been designed in such a way as to enable each participant to complete it in their own time without the presence of the experimenter. This was necessary, because the study required the participants to dedicate a considerable amount of time (sometimes up to 1.5 hours overall) and effort to completing it. Given that most of the participants were school teachers overloaded with high levels of preparation for their usual duties, it seemed neither reasonable to expect the teachers to do the study in one sitting, nor was it reasonable to expect them to do it during school hours.

Altogether, there were three versions of the study: the first pilot, the second pilot and the final study. The second pilot and the final version of the study were identical except for the number of situations that were tested per teacher: in the second pilot the teachers were given ten different situations, while in the final study they were given only five. Because some of the design decisions were motivated by the first pilot, the first pilot is discussed whenever relevant. Otherwise the following description and the analysis concerns only the second pilot and the final version[2].

[2]The details of the first pilot were described in Porayska-Pomsta *et al.* (2000b) reproduced in the

5.3.1 Participants

Altogether twenty six participants took part in the study. Eight of them took part in the first pilot, seven participated in the second pilot, while the remaining eleven completed the study proper. In the first pilot all of the participants were university tutors (all were graduate students) with at least one year of teaching experience, but with no professional training. The eighteen participants in the second pilot and in the final version of the study were either experienced teachers with professional training, or they were university lecturers with extensive teaching experience. Between them they had 276.5 years of experience which makes for an average of just under 15 years of experience per participant. All of the eighteen participants were trained or worked predominantly in the United Kingdom and all were native British English speakers.

As was mentioned already, the current analysis considers only the responses from the total of eighteen teachers participating in the second pilot and in the final version of the study. This is because (a) the two versions of the study are identical and (b) unlike in the first pilot, the professional qualifications and experience of all of the participants were equally extensive.

5.3.2 Materials and Procedures

The materials were presented as hard-copy questionnaires. Each of the participants was given five to ten different situation descriptions to assess. An example of a situation description with which the teachers were presented is shown in figure 5.1. The participants were asked to complete two tasks in relation to each of the situations.

In the first task, each teacher was asked to make notes as to the particular aspects of a given situation which they felt would influence them the most. They were also encouraged to give examples of possible linguistic responses to every given situation. For this task, three quarters of a blank A4 size page was provided immediately underneath each situation description.

Appendix E.

You have one topic left to cover in the current lesson and you have very little time left at your disposal. The topic is crucial to student's overall understanding of the subject. The topic is also relatively difficult. The student that you are dealing with is not confident, but has a good sense of humour. He seems bored with the lesson. His overall progress is fast, but his latest answer is only partially correct. Your rapport with the student is an informal one.

Figure 5.1: An example situation description.

The second task required the teachers to rate every situational factor-value in each situation, according to how important it appeared to them in that situation. For each situation and for each factor in the situation, a scale from 1 to 5 was provided. The teachers were asked to use this scale to indicate their choices. The two ends of each scale were marked with *Not Important* for the end starting with the number 1 and *Very Important* for the end finishing with the number 5. An example of a scale that the teachers were asked to use is given in figure 5.2. The participants were asked to choose one of the importance scores for each factor.

The situation descriptions were constructed out of ten situational factors listed in figure 5.1, where the underlying factor-values for the situation description shown in figure 5.1 are also given. As mentioned earlier this includes two more factors than have been proposed in Chapter 4. The additional factors are the FORMALITY of the teacher-student rapport and the STUDENT'S SENSE OF HUMOUR. The reason for these two factors being included in the study is to confirm the claim made in Chapter 4 regarding the relatively small influence of the social distance on teachers' linguistic decisions and to verify the importance of students' sense of humour to such decisions.

A combination of ten factors each allowing for two mutually exclusive values leads to 2^{10}, i.e., 1024, factor-value permutations. In order to test all 1024 different situations at least once, as many as 104 to 205 teachers would have to participate in the

Importance of material:				
Not Important				Important
1	2	3	4	5

Figure 5.2: Example of the importance scale for the factor: Importance of material.

1. Amount of time left:	very little
2. Amount of material left:	1 topic
3. Importance of material:	crucial
4. Difficulty =	difficult
5. Student's confidence:	not confident
6. Student's interest:	bored
7. Student's aptitude:	high
8. Correctness of student's last answer:	partially correct
Additional factors not accounted for in the model	
9. Formality of the student–teacher rapport:	informal
10. Student's sense of humour:	good

Table 5.1: Values for the factors underlying the context description in figure 5.1

study depending on whether five or ten situations were tested per participant. This was unrealistic, given that the author had a limited access to the subject pool. If one were to eliminate the formality and sense of humour factors, the resulting number of situations would have been 2^8, i.e., 256. Although, much more realistic this number still required at least twenty six subjects in order for each situation to be tested at least once. Because the idea was to test each situation at least twice, the number of combinations had to be reduced by at least another two situational factors. This led to 2^6, i.e., 64, situations requiring the minimum of thirteen participants to complete the study assuming that each participant was given 5 situations to assess.

Due to the small number of participants and their relative lack of experience, the first pilot could not be used as a fully reliable source of information as to the factors that could be explicitly eliminated from the situation descriptions. Instead, the pilot was used to indicate those six factors which were rated as the most important overall. These were TIME LEFT, DIFFICULTY OF MATERIAL, STUDENT'S CONFIDENCE, STUDENT'S INTEREST, STUDENT'S APTITUDE and CORRECTNESS. The sixty four situation descriptions were generated automatically out of the six factors and their values, using a simple depth-first search algorithm implemented by the author to ensure consistency and to eliminate mistakes. Because the remaining four factors which, apart from the FORMALITY and the SENSE OF HUMOUR, included AMOUNT OF MATERIAL LEFT and IMPORTANCE OF MATERIAL, could not be reliably eliminated based on the indications of the first pilot, their individual values were included in the automatically generated situation by hand in an alternate manner. Thus, each situation description given to the participants consisted of one of the possible values of a consistent combination of the six factors identified in the first pilot as the most important, and of a randomly distributed combination of the four less important factors.

5.4 The Results

21 teachers committed themselves to completing the final version of the study. Unfortunately, only 11 actually returned the completed questionnaires. Such low return may

have been due to the effort required to complete the study as on the whole teachers found the task of imagining the situations and reasoning about them in terms of all ten factors quite challenging (see the following subsections and section 5.5 for a discussion of the validity of the data). This low return also means that out of the sixty four situations tested, some situations were seen by more than one teacher, while some of them were not seen by any teacher at all.

Altogether a total of 112 situations were seen by the 18 participants. Out of the 64 situations included in the study, 54 situations were actually seen, leaving 10 situations unaccounted for. 18 situations were seen only once, 28 were seen twice, and 5 situations were seen more than twice.

5.4.1 The validity of situational factors

Despite finding the task of reasoning about the ten factors in terms of the dry situation descriptions rather difficult, teachers demonstrated great familiarity with the factors. Overall only three participants either questioned the applicability of a factor despite giving a rating for it on the importance scale, or failed to rate certain factors in some situations. Two participants had a problem with the formality of teacher–student rapport. In one case the participant questioned its applicability to the kind of educational situations to which she was normally used. In the other case, the participant failed to rate the formality factor on the importance scale in two situations. Instead, in both cases, she marked the appropriate scale with a question mark, although it is impossible to ascertain whether she questioned its applicability to each of the situations, or whether she was confused as to the aspect of a situation to which the factor referred. The third problematic participant failed to rate a number of different factors with respect to their importance. Unfortunately no comments were provided by him to explain the omissions. Since on the whole all three participants managed to rate and to comment about most of the factors in at least a few situations, their answers were included with the rest of the results.

The fact that the majority – a total of 15 – of the participating teachers were able to rate and to make detailed notes about the effects of the situational factors on their linguistic decisions gives strong support for the relevance of those factors to the educational situations in question here, and thus validates them for the purpose of the current model. The comments also provide a certain amount of support to the statistical analysis of the actual ratings of the factors. In most cases teachers referred to specific factors and to factor combinations when describing their possible responses. Many of the teachers linked those factors to concrete examples of the linguistic responses that they would consider appropriate for the given situations. This information is used to motivate and to support further the linguistic component of the model which is presented in detail in the next chapter. Other teachers linked the factors to examples of the steps that they would undertake in addressing a given situation, providing further, though indirect, motivation for certain design decisions in the model.

5.4.2 Relative relevance of factors to teachers' decisions

A descriptive analysis was used to determine whether or not the ten factors were perceived by teachers as equally relevant to their decisions. The results of the analysis given in table 5.2 show that the mean scores for the factors overall, i.e. regardless of their values, differ suggesting that, in general, teachers do perceive the factors as having a different effect on their decisions across the tested situations. The relatively small standard deviations for each of the mean scores indicate a small spread of scores and a relatively large agreement amongst teachers as to the means across different situations, with the relatively low overall score for the situational factor AMOUNT OF MATERIAL having the highest spread and the lowest overall agreement associated with it (SD = 1.28), and the STUDENT'S CONFIDENCE along with the STUDENT'S INTEREST having the lowest (SD = 0.85) spread and the highest agreement associated with them. The fact that there seems to be relatively little variance between the scores of different teachers suggests that some factors are generally regarded as more important than other regardless of the situations in which they occur. The factors that were rated the highest and which ratings were agreed upon by a vast majority of the participants, were the STUDENT'S CONFIDENCE, STUDENT'S INTEREST and the STUDENT'S AP-

Table 5.2: Relative overall importance of individual situational factors

Variable	**Mean**	**SD**	**SE**	**N**
Aptitude	3.93	1.02	0.09	111
Amount of time left	3.70	1.09	0.1	111
Amount of material left	2.96	1.28	0.12	112
Difficulty of material	3.58	1.05	0.99	111
Importance of material	3.63	1.09	0.1	111
Correctness of S' answer	3.57	1.05	0.09	111
Confidence	4.01	.85	0.08	112
Interest	3.88	.85	0.08	111
Additional Factors				
Formality	2.52	1.21	0.11	109
Sense of Humour	2.63	1.09	0.1	112

TITUDE, closely, but not consistently, followed by the DIFFICULTY OF MATERIAL. The reliability of the mean scores in table 5.2 is further supported by the relatively small standard errors for each mean. The factors in italics represent those factors which were randomly distributed across the 64 situations.

The overall means of the FORMALITY factor and of the STUDENT'S SENSE OF HUMOUR indicated that the two factors were rated as less important than the other eight factors. To confirm that these two factors were indeed given lower ratings than the remaining factors, a weighted simple comparison of means was carried out. This confirmed that there was a difference between the two groups of factors (F(1,111) = 109.73; $p < 0.001$)[3].

The results of the simple comparison of means are used in the current thesis to justify further the elimination of the distance variable from the model developed here and

[3] For this analysis, the missing values in the data were replaced with the score '3" (a midpoint of the scale).

which in Chapter 4 is claimed to be held relatively constant in the types of educational situations considered here. This is further supported by teachers' comments many of whom stated explicitly that in their experience this factor does not apply: *"[...] rapport with student should not vary too much + would not affect the lesson"*[4]. On the other hand, given the low mean scores of the STUDENT'S SENSE OF HUMOUR suggests that contrary to the first, informal indications, in this study teachers did not perceive this factor as very important to their decisions. Confusingly, this is not supported by their comments in which they explicitly state that student's sense of humour often facilitates encouragement and motivation boosting, e.g., *"The student is bored, because the topics are hard. Therefore be easy going (relate to her sense of humour [...]"*[5]. Ultimately, because there is no appropriate information available in the two sets of dialogues analysed in Chapter 3 regarding the possible link between the sense of humour factor and language produced by teachers, the factor is abandoned in the current model.

To check whether or not the individual values of each factor affected the overall mean score of each of the eight factors, a similar descriptive analysis of means was carried out (the reader is referred to Appendix B for detailed results). In this analysis each factor overall was checked against each of the possible values of every of the eight factors in turn. The results indicated that while in general the individual changes in the ratings of the factors were not drastic, i.e. in no case there is a change from a very low to a very high score, nevertheless, given the different values of the factors against which the checking is done, there is a visible amount of variation in the overall ratings of some of the factors. This is illustrated in the table 5.3.

In the current example, while AMOUNT OF TIME LEFT and the STUDENT'S INTEREST overall do not seem to change dramatically depending on whether or not the student is interested or bored, there are changes in the teachers' overall perception of the importance of other factors to their linguistic decisions. For example, the importance of the STUDENT'S APTITUDE rises if the student is bored. This is probably because teachers tend to address student's boredom by making the task either more challenging, if the task is too easy, or less challenging, if the task is too difficult, based

[4]Subject A, 2.5 years of experience.
[5]Subject D, 3 years of experience.

Table 5.3: Changes in mean scores of situational factors given student's interest: *interested* and *bored* respectively.

Factor	**S' Interest: interested**				**S' Interest: bored**			
	Mean	**SD**	**SE**	**N**	**Mean**	**SD**	**SE**	**N**
Amount of material	3.11	1.31	0.176	55	2.81	1.25	0.16	57
Difficulty	3.65	1.04	0.14	55	3.50	1.06	0.14	56
Amount of time left	3.71	1.13	1.15	55	3.70	1.06	0.14	56
Importance of material	3.73	1.06	0.14	55	3.54	1.13	0.15	56
S' aptitude	3.76	1.09	0.146	55	4.09	0.92	0.12	56
Correctness	3.76	0.98	0.13	55	3.39	1.08	0.14	57
S' interest	3.95	0.76	0.1	55	3.82	0.94	0.12	56
S' confidence	4.11	0.88	0.1	55	3.91	0.83	0.1	57

on their assessment of the student's demonstrated abilities. On the other hand, the importance of the CORRECTNESS of the student's answer decreases when the student is bored. This may be because to address a student's boredom is more important to teachers than to correct him immediately. Similarly the importance of the STUDENT'S CONFIDENCE decreases when the student is bored suggesting that the student's boredom is a very important issue in need of being remedied. Notice that despite dropping in importance, the student's confidence still seems to be regarded as more important than the student's interest and any other of the eight factors. Again, while the relatively small standard deviations suggest teachers' agreement as to these tendencies across different situations, the relatively small standard errors suggest that the results are stable.

5.4.3 Relations between factors

In order to check for the relations between individual factors across the situations, the Pearson's coefficient analysis was conducted. The analysis shows that the ratings of certain factors correlate with one another, which in turn supports the assumption that there may be certain ways in which the factors can be grouped naturally. Table 5.4 shows the entire correlation matrix for the factors overall. The results shown in table 5.4 in bold represent the statistically significant results.

In relation to the assumptions made in Chapter 4, the data confirms only some of them. In particular, the analysis shows a positive correlation between the AMOUNT OF TIME LEFT and the AMOUNT OF MATERIAL LEFT (.3654; $p < 0.001$), thereby supporting the speculations that they may belong to the same (temporal urgency) group of factors. On the other hand, there is no evidence whatsoever in the data which would support the grouping of the STUDENT'S CONFIDENCE and STUDENT'S INTEREST, which is suggested indirectly by Lepper and Chabay (1988), for instance.

The analysis also throws light on other possible groupings of factors, with the strongest correlation values suggesting the grouping of DIFFICULTY OF MATERIAL and the AMOUNT OF MATERIAL LEFT (.4627; $p < 0.001$), and the DIFFICULTY OF MATERIAL with the IMPORTANCE OF MATERIAL (.6540; $p < 0.001$).

One of the most interesting relations was found between the CORRECTNESS OF STUDENT'S ANSWER and the STUDENT'S INTEREST which are negatively correlated (-.2508; $p < .05$). This means that when the importance of CORRECTNESS goes up, the importance of INTEREST goes down and *vice versa*. This negative correlation seems intuitively plausible in that the correctness of student's answer, especially if it is *incorrect* could be expected to influence the importance of student's interest negatively, especially if the student's interest is *low*. In such cases the student's incorrect answer may be caused by his lack of interest in the current task. Thus, in order to remedy the situation, the teacher may decide that the best way to correct the student's misconception is by addressing his boredom first. Indeed, the possibility of such decision is confirmed by the comments made by many teachers, who say that motivating the stu-

Table 5.4: 2-tailed Pearson's correlation matrix between various situational factors

	Aptitude	**S' Confidence**	**Correctness**	**Difficulty**	**Importance of mat.**	**S' Interest**	**Material left**	**Time left**
Aptitude								
S' Confidence	**.2407** **(111)** $p < 0.05$*							
Correctness	-.0807 (111) $p = 0.4$	.0547 (112) $p = 0.566$						
Difficulty	**.2697** **(111)** $p < 0.05$*	**.2870** (111) $p < 0.05$*	.1376 (111) $p = 0.15$					
Importance of mat.	**.2048** **(111)** $p < 0.05$*	.1487 (111) $p = 0.119$	.0654 (111) $p = 0.49$	**.6540** **(111)** $p < 0.001$**				
S' Interest	.1586 (111) $p = 0.096$	.1136 (111) $p = 0.23$	**-.2508** **(111)** $p < 0.05$*	-.0867 (111) $p = 0.366$	-.1641 (111) $p = 0.085$			
Material left	**.2143** **(111)** $p < 0.05$*	**.2880** **(112)** $P < 0.001$	-.0479 (112) $p = 0.616$	**.4627** **(111)** $p < 0.001$**	**.4394** (111) $p < 0.001$**	-.0489 (111) $p = 0.611$		
Time left	.1281 (111) $p = 0.18$	.1096 (111) $p = 0.25$	.1089 (111) $p = 0.25$	.1034 (111) $p = 0.28$	.0898 (111) $p = 0.34$	.0307 (111) $p = 0.74$	**.3654** **(111)** $p < 0.001$**	

dent is sometimes more important than correcting him, e.g.,: *"[...] if [topic] difficult and his confidence low [...] pass on [the topic] and return if necessary"*[6]. Furthermore, many teachers linked the student's interest versus correctness to the amount of time left. Typically, they explained their reasoning in the following way: more time means less pressure on them to correct the student immediately, and hence more time to concern themselves *"[...] with issues of student's attitude to the subject"*[7], i.e. with addressing his lack of interest.

Finally, the grouping that has not been considered as a pre-requisite for the model, and which the participant of the current study clearly perceived as occurring is that between the DIFFICULTY OF MATERIAL and the STUDENT'S CONFIDENCE which is characterised by a low, but nevertheless significant coefficient (.2870; $p < .05$). Again, this is intuitively plausible; it is much more difficult to teach difficult material to a non-confident student than to a confident one. Thus, while the more important the DIFFICULTY OF MATERIAL is, the more important should the STUDENT'S CONFIDENCE be. Surprisingly, teachers made no written comments whatsoever about this relationship. Instead, some of them related STUDENT'S CONFIDENCE to the importance of completing a task at hand as a way of boosting the feeling of achievement and hence the self-esteem. This is also supported by the motivational literature such as de Vicente (2003). Perhaps the way to interpret the correlation between the DIFFICULTY OF MATERIAL and the STUDENT'S CONFIDENCE is best done through the prism of completion and achievement: if the student knows that a task is difficult then completing it will give him the sense of accomplishment, which in turn may boost his confidence, which somehow suggests an indirect rather than an direct link between the two factors.

The analysis of the relations between the factors and their individual values provides further clues as to the possible groupings of factors. Most importantly the assumption that STUDENT'S APTITUDE and CORRECTNESS OF STUDENT'S ANSWER may be related is partly confirmed by this test. When the student's progress is *slow* and his last answer was *incorrect*, the factors are shown to be negatively correlated (-.3563; $p < .05$). Also, while there was no support found for the speculations as the

[6] Subject JH, 30 years of experience.
[7] Subject H, 22 years of experience.

to relationship between the DIFFICULTY OF MATERIAL and the STUDENT'S INTEREST overall, some support can be found on the level of the relationships between the individual factor-values. The two factors seem to be especially strongly related (.4381; $p < 0.05$) when the material is *easy* and the student is *interested*.

Although the correlation matrix provides a useful basis for speculation regarding the possible groupings of factors, it does not inform one as to the extent to which these factors reflect the same underlying situational phenomena. The task is made even harder given the relatively large number of dimensions (the situational factors) in the current space analysed. Furthermore, given a relatively sparse data set, it is difficult to claim for certain that the significance of the correlations in table 5.4 did not result from this data sparsity, which is one of the most common problems with assessing the trustworthyness of coefficients.

In order to confirm the relations between certain factors and in order to gain a better, clearer idea as to their possible groupings, a Principle Components Factor Analysis was carried out using Varimax Rotation. The main gist of this analysis is the reduction of the dimensionality of space and the determination, given sufficient data, of the factors commonly underlying different sets of variables (here – situational factors).

The analysis revealed three main groupings of variables shown in table 5.5 under the names *Factor 1*, *Factor 2* and *Factor 3* respectively. The most significant loadings of each situational factor are indicated in the table in bold.

By far the strongest group, accounting for 30.6% of variance is that represented by the component called Factor 1. There are three situational factors which load strongly on this component, namely DIFFICULTY OF MATERIAL, IMPORTANCE OF MATERIAL and AMOUNT OF MATERIAL LEFT. This is partially in agreement with the tentative grouping proposed in Chapter 4 in which the first two factors were referred to as the *characteristic of the material* taught. The third situational factor in this group, the AMOUNT OF TIME LEFT, was referred to in Chapter 4 as one of the *temporal urgency* factors and was said to belong together with the AMOUNT OF TIME LEFT. Surprisingly, and in conflict with the significant coefficient shown in table 5.4, this grouping is not confirmed by this analysis which places it in the third component called Factor

Table 5.5: Results of the Principle Component Analysis using Varimax rotation based on the correlation matrix in table 5.4.

	Factor 1	**Factor 2**	**Factor 3**
Importance of Aptitude	.40481	**.47510**	.21409
Importance of Confidence	.36067	.26638	**.38474**
Importance of Correctness	.02539	**-.69669**	.28004
Importance of Difficulty	**.86805**	-.06492	.07261
Importance of Importance of material	**.85887**	-.12901	-.04320
Importance of S' Interest	-.19055	**.75370**	.15698
Importance of Material left	**.61471**	.06487	.46683
Importance of Time left	.01028	-.08377	**.89061**
percentage explained variance	30.6	17.5	13.2

3 together with STUDENT'S CONFIDENCE.

The second component accounting for 17.5% of variance indicates that the situational factors STUDENT'S APTITUDE and CORRECTNESS OF STUDENT'S ANSWER can be clustered together. Furthermore the factor STUDENT'S INTEREST loads strongly on this component, which is in line with the preliminary group proposed in Chapter 4 in which these factors were placed under the *characteristics of the student*. The variable which does not conform to this preliminary grouping is he situational factor STUDENT'S CONFIDENCE which just like the AMOUNT OF TIME LEFT loads on the third component. The third component account for only 13.2% of variance.

Although the groupings proposed in Chapter 4 were not entirely confirmed by the Principle Component analysis, the analysis does provide an indication as to the factors which may belong together much more strongly than the coefficient measures. In Chapter 6 the results of this analysis are not followed literally in the design of the model. This is because the groupings of certain factors are somewhat counter-intuitive and moreover they do not conform to the recommendations made in the relevant literature. In particular the fact that AMOUNT OF TIME LEFT is classified here as separate from the AMOUNT OF MATERIAL LEFT seems counter-intuitive. As was discussed in Chapter 4, intuitively the two factors seem to belong together, which is supported by their significant coefficient. It is possible that this classification is the result of the way in which the study was designed. For example, it is possible that the design was unbalanced in the way the various situation descriptions were lexicalised and which lexicalisation affected this particular grouping. Similarly, the classification of confidence as being separate from other *student's characteristics* clustered under Factor 2, is surprising. On the other hand, given that the problematic Factor 3 accounts for only 13.2% of variance, and hence is the least reliable, leaves space for maneouver in terms of the actual design of the model. Ultimately, as will be discussed in Chapter 6, the results of the Principle Component Analysis are taken as a solid, but not entirely reliable guide to informing the structure of the situational component of the model. In the model, the three groupings are retained as are most variable clusters that result from this analysis: while the situational factor AMOUNT TIME LEFT is grouped together with the AMOUNT OF MATERIAL LEFT, the STUDENT'S CONFIDENCE and the STUDENT'S INTEREST are grouped together to represent the student's motivational characteristics.

5.5 Discussion

The task of reasoning about the different situations proved very challenging to many teachers who participated in the study. The main problem derived from the fact that for each situation, the participants needed to remember all of the ten factors and their values in order to make measured decisions. This may raise a question as to the validity of the results obtained from this study. If teachers found it difficult to reason about the situations, then the results may not be indicative of the way in which the teachers would respond in real situations. However, if it is indeed the case that the teachers were confused in some way, then the results show that they were confused in a consistent manner, based primarily on the standard deviation and standard error of the mean scores. One way in which to test for the possible confusion would be to compare the results of this study to the results of another study in which the same teachers would be asked to observe natural interactions between a teacher and some students. The interactions would substitute the situation descriptions and would have to be controlled in specific ways to ensure that the ten factors and their values were present and observable to the teachers.

Given the consistency of the results, they are taken as a good indication of the tendencies in the way that the teachers would address different situations. In that respect the study provides at least partial answers to each of the three questions that it was designed to address.

The most encouraging and the most clear-cut result is reflected in the fact that, despite the difficulty of the task with which they were presented, most teachers managed to relate the ten situational factors to their own experience, and that they discussed the role of those factors in their possible decisions, in a coherent and an informed manner. Teachers' sensitivity, reflected in their written comments, to the different definitive impact that eight factors have on their individual decisions provides the strongest validation of those factors in terms of their applicability to educational contexts in question. It is possible to argue that the fact that the teachers related to the situational factors presented to them was simply because the factors were listed for them. Thus, one could argue that if asked to name the important factors without being primed in any way, the teachers could/would suggest different lists. However for each situation the teachers were asked to specify any other factors which they thought may be relevant and not a single questionnaire was returned with additional suggestions. Perhaps the lack of the relevant comments was due to teachers' being pressed for time, or the fact that the questionnaires required a lot of effort to complete. But this explanation does not seem entirely satisfactory given that the same teachers provided extensive comments about the reasons for which they found the situational factors listed relevant.

The results also show that the pre-requisites of the model discussed in Chapter 4 are based on certain assumptions which may be grounded in real teachers' long-term experience. When combined in various ways the different factors and their values seem to have different effects on the teachers' perception of their importance to their linguistic decisions. This provides some empirical evidence needed to support the claim that the variations found in teachers language are the result of the variations in the individual factor-values and of the effects that such variations may have on the nature of other factor-values co-occurring in the same situations. While a change in one factor-value may not affect an overall decision, the change in another factor-value may cause a change in the perceived importance of other co-occurring factors. The study of the relations between the factors informs one about those factors of which the combination may lead to such strong effects, e.g., as is suggested by the strong correlation between the IMPORTANCE OF MATERIAL and the DIFFICULTY OF MATERIAL. Furthermore, such analysis points to the possible ways in which the factors can be grouped together. As will be discussed in Chapter 6, this information is particularly valuable not only in the process of deciding on the structure of the model, but also in determining the nature and the strength of the contributions by the individual factors to the assessement of situations in terms of the Autonomy and Approval dimensions (see Chapter 4, for definitions of the two dimensions).

The comparison of the mean values of each factor overall indicates that some factors may be perceived by teachers as universally more important than others. This means that while all factors may have a potential impact on teachers' decisions, only some will always contribute more to those decisions. The teacher's written comments seem to support this interpretation of the data. For instance, at least half of the participants who made written comments emphasise the crucial importance of addressing a student's motivation and confidence, often in the face of slow progress and lack of correctness. For example, in a situation in which the student is *not confident*, his answer is *incorrect* and his progress is *slow*, one teacher explains the factors that he would find the most important as shown in the example 5.1.

(5.1) *" Boost confidence - confirm correctness of previous answer and how well he has done. Repeat question using different language/example and again ask him to explain the steps in arriving @ the current answer – Very leading and pointed questions if he seems slow in responding or appears stuck.[...] Confirm* *each logical step. Sound involved in his learning. Encouragement”*[8].

Also the comments somewhat implicitly suggest that there may be different levels of generality at which the factors are perceived. This also has an effect on the perceived prominence of factors, especially in individual situations. Thus, while the student’s lack of confidence tends to lead to teachers’ goals which need to be achieved immediately, factors such as the student’s aptitude and the correctness of the student’s answer tend to be referred to in the notes as longer term lesson goals. This is especially true if there is plenty of time left till the end of a lesson which may allow a teacher to lead the student to a correct reasoning path in a motivating, considerate manner. Having said that AMOUNT OF TIME LEFT often takes precedence in terms of its importance ratings over CORRECTNESS OF STUDENT’S ANSWER, because many teachers believe that to finish a lesson in a manner which would not be detrimental to the student self-esteem and motivation is more important than to repair student’s misconceptions immediately, before time runs out.

Those of the teachers’ written comments which attempt to give reasons for the overall ratings of factors are used to inform the way in which the weightings of the individual contributions by factors are captured in the model presented in the next chapter (for an example see 5.2). In particular those weightings are expressed in the rules used to combine the various factors and which rules are subsequently used to inform the implementation of the situational component discussed in Chapter 7.

(5.2) *The student needs encouragement and reassurance and there is some source of misconception. Important to close with as positive an attitude as possible rather than pushing to complete the material.*[9]

Teacher’s comments are also used to link the type of language used in response to different situations. Unfortunately less than half of the participants made explicit comments about the language they would use and even less provided examples of their

[8] Subject AT, 3 years of experience.
[9] Subject H, 22 years of experience.

exact responses in relation to the factors that they found salient in given situations. However, most of those teachers who gave examples of their possible responses also referred to concrete teaching approaches (or strategies) which they thought were most appropriate in given situations. The most typical responses consisted in explantions such as that in example 5.3.

(5.3) *This is all going well except for the boredom and the wrong answer. It suggests that a little concentration is all that's required, so I'd probably be basically lecturing (using technical language and sentences as long as necessary), but trying to include humour to get the student's interest and prompting for understanding acts (and actual pieces of knowledge) in an attempt to keep the student engaged.*[10]

An interesting and a consistent suggestion made by the teachers was that whether a direct or indirect approach to getting the student back on the right reasoning path is taken depends on the STUDENT'S SENSE OF HUMOUR. In situtions where the student was characterised as having a good sense of humour, the teachers tended to respond in a more direct manner, usually telling the student that his answer was incorrect and turning it into a joke, for instance. In situations where the student was not confident enough to take a direct approach, a number of teachers proposed making "silly suggestions" which they would hope the student would recognise as absurd and thus he would realise the error in his answer. Unfortunately, as was explained earlier, these comments were not reflected in the scores that teachers assigned to this factor. However, for any future models of the relationship between situational contexts and language it is worth keeping in mind that, in theory, teachers find humour a very useful educational and motivational tool.

[10] Subject C, 16 years of experience.

5.6 Summary

This chapter presented a design of the study which was used to validate certain assumptions made in the previous chapters of this thesis, and to provide statistical basis for the design of the situational component of the model presented in Chapter 6. While due to the small data set, the results of the study cannot be taken as providing definitive answers to the questions asked earlier in the chapter, they do provide an indication of teachers' perception of situational context and its influence on their individual, specific decisions. These indications show that:

- teachers recognise the eight situational factors as relevant to the educational situations in which students' need to be corrected.
- teachers perceive the factors as having different impact on their linguistic decisions.
- some factors are related to one another which, as confirmed by the Principle Component Analysis, may be an indication of the way in which they can be grouped naturally and which grouping can be linked to the particular aspects of teachers decisions (e.g. some factors may impact on the amount of autonomy that the teacher may want to give to the student, while other factors may have an effect on the amount of approval that the teachers offer to the students).

Following the results of the Principle Component Analysis, most groupings revealed by the analysis are used in the situational part of the model presented in the following chapter. However the placement of the situational factors resulting from the analysis which seems counter-intuitive based on the proposals from the educational literature and from the analysis of the dialogues, are changed.

In the next chapter these indications are exploited as they lend support to many of the design decisions of the situational model.

Chapter 6

The Model

6.1 Introduction

This chapter presents the components of a pragmatic model of linguistic feedback selection by teachers. It provides a detailed description of the model's two main components: the Situational Component and the Linguistic Component. The situational component formalises the processes by which a given combination of situational constraints can influence teacher's linguistic choices through deriving the Autonomy and Approval ($\langle Aut, App \rangle$) values appropriate for the given combination. The linguistic component consists of two sub-components: (1) the strategic system and (2) a set of surface forms used as corrective feedback in the Pittsburgh dialogues. The strategic system provides a coherent, not automated, method for assigning the Autonomy and Approval values to the surface forms in the set. The $\langle Aut, App \rangle$ output from the situational component characterises a given situation in terms of Autonomy and Approval dimensions, thereby specifying the pre-conditions for selecting a response to that situation. For a surface form to be considered a good candidate response to a situation, the $\langle Aut, App \rangle$ values associated with the form must be as close as possible to the $\langle Aut, App \rangle$ values produced by the situational component. Figure 6.1 illustrates the relationships between the components of the model, also exemplifying a path from a possible situation to the choices of surface forms recommended in response to that situation.

The model is based on the assumptions stated in Chapter 4 which in some cases represent certain theoretical simplifications – for example Face is defined as characterising only the needs and wants of a student, while situational factors are defined only in terms binary values. As is explained in the following section, further simplifications are involved in the way in which the situational factors are combined – specifically in the way in which the numerical values referring to the weightiness of a factor in a given situation are inferred. Although these numbers are intended to reflect the general tendencies as to the relative importance of the factors in given situations based on the results of the study presented in Chapter 5 nonetheless the actual numbers are based on a certain amount of arbitrariness. This point is elaborated on further when the rules for combining the situational factors are explained in more detail in subsection 6.2.3.1.

The chapter is organised as follows. Section 6.2 describes the situational part of the model: it explains the nature of the situational factors, it justifies the way in which the factors are combined, and it shows how these combinations are used to produce the Autonomy and Approval values. Section 6.3 catalogues the feedback strategies identified in the educational dialogues studied, and presents them in the form of a decision tree for assigning the Autonomy and Approval values to individual surface forms. The catalogue of strategies is referred to henceforth as the *strategic system*. The section also discusses the way in which the strategies may combine to produce complex surface forms along with the method for calculating the Autonomy and Approval values for such forms. Section 9 draws conclusions regarding the model presented in this chapter in relation to the theoretical and empirical material presented in the previous chapters and in preparation for the discussion of the implementational and evaluation issues in the following chapters.

6.2 The Situational Component

The purpose of the situational component (shown in figure 6.2) is to represent in a coherent and a formal way the processes by which a combination of situational factors

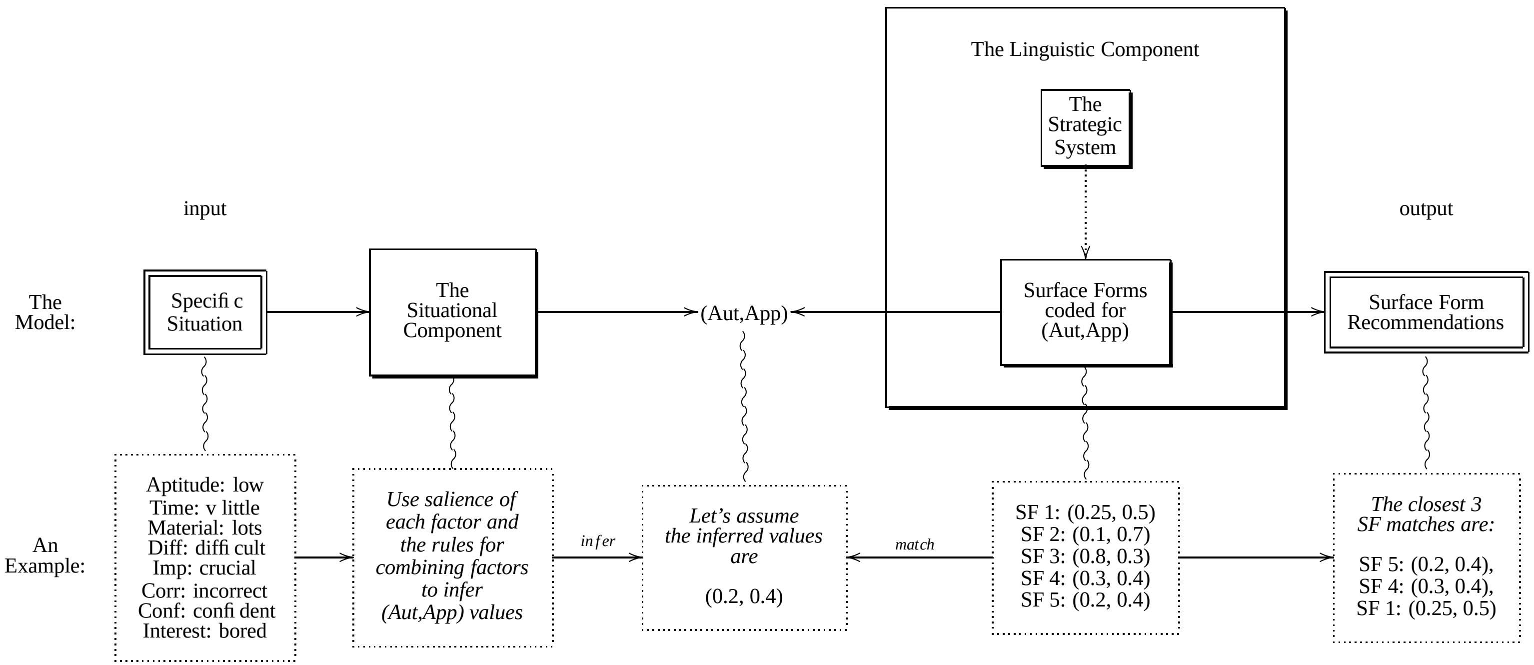


Figure 6.1: The Overall Model

can determine teacher's linguistic choices. This representation relies on the relation that has been assumed in Chapter 4 between the situational constraints and the Autonomy and Approval dimensions along which teachers' linguistic choices are made. In Chapter 4, situational context has been defined for the purpose of the current model and a catalogue of all the situational factors relevant to the model has been provided and theoretically motivated. In Chapter 5, it was discussed how the relevance of these factors was investigated by means of the exploratory study, the nature of the dependencies between the factors was explored, and their relative importance to teachers' decisions regarding the appropriate feedback moves was given. This section builds on the assumptions and findings of the previous chapters; it discusses the nature and the role of the individual situational factors in the model, the way in which these factors are combined to evoke communicative and educational goals, and ultimately – the way in which they lead to the Autonomy and Approval values.

In figure 6.2, *situation* constitutes the top-most level of the situational model. A situation is composed of eight factors (shown at the second level) each of which belongs to one of three possible groups: the lesson oriented factors (*LOFs*) concerned with temporal aspects (in the figure these are *Tfs*) and the content taught matters (*Cfs*), the motivation oriented factors (*MOFs*) concerned with the student's emotional and motivational characteristics, and performance oriented factors (*POFs*), which inform the model with respect to a student's ability vis à vis the correctness of his actions. Each factor may contribute to the calculation of the amount of Autonomy and the amount of Approval to different degrees, depending on a given situation in which it occurs. The level of contribution of a factor, also referred to throughout the rest of the thesis as the *importance* of a factor or its *salience*, is indicated in the figure by the letter "S" followed by the first letter or letters of the factor name.

Each factor either by itself or by combining with another factor, evokes goals (levels four, five and six). The goals reflect the nature of the factors that gave rise to them in the first place. Each goal has a salience associated with it, which is passed on to it from its parent factors. The situational model distinguishes between two types of goals: the *local goals* and the *global goals*. Essentially global goals are the goals

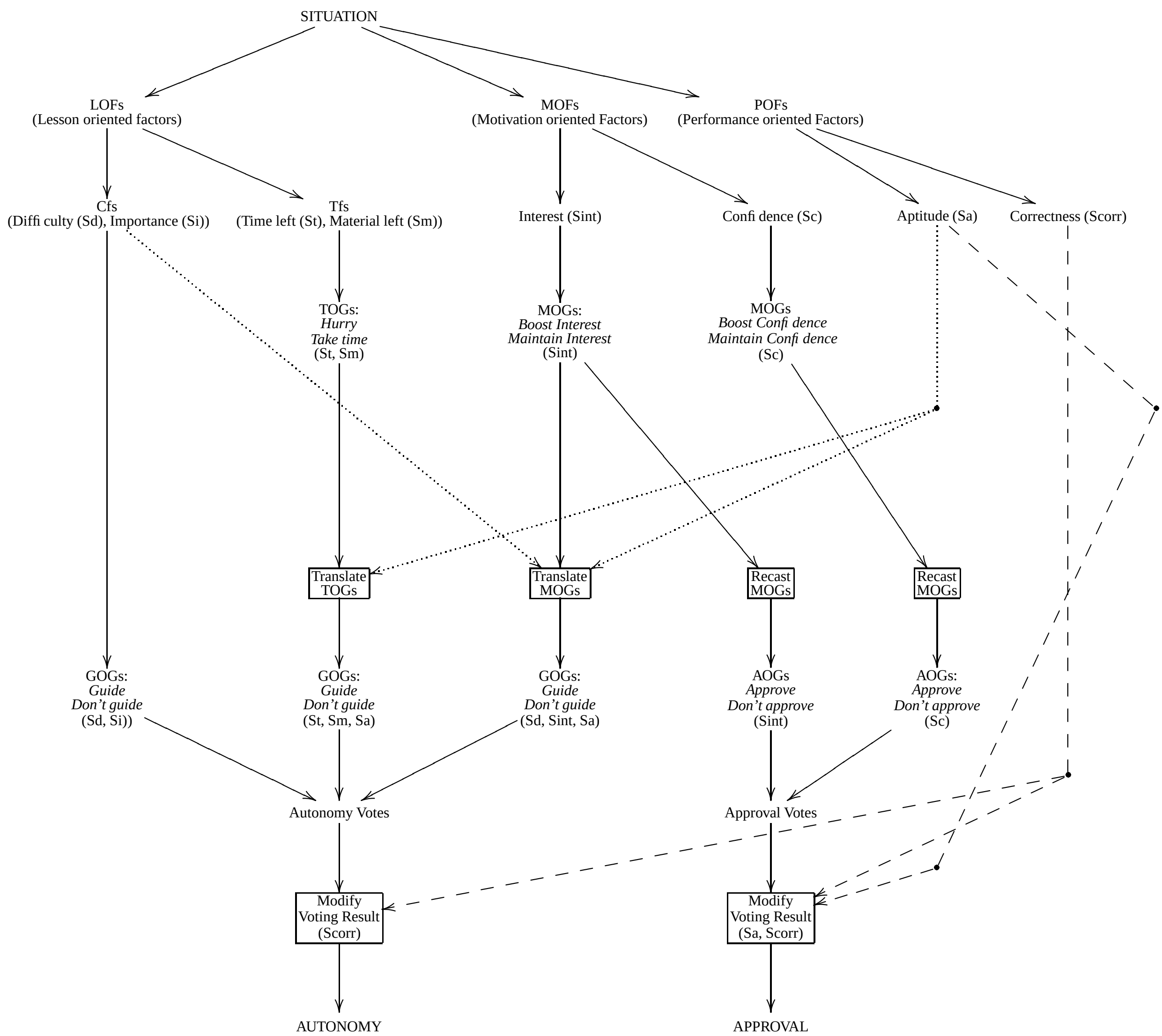


Figure 6.2: The situational component

which map directly onto the Autonomy and Approval dimensions which constitute the driving force behind the model. Such goals are expressed either as *Guide* or *Don't guide* for the Autonomy dimension, or as *Approve* or *Don't approve* for the Approval dimension. As can be seen in figure 6.2, only *Cfs* give rise to the global goals directly. Other factors give rise to local goals. For example, *very little time left* gives rise to a temporal local goal *Hurry*, while a *not confident* student evokes a teacher goal *Boost confidence*.

In order to acquire meaning in terms of Autonomy and Approval, the local goals need to be either translated or recast (level five). The translation is needed for those goals which cannot be consistently paraphrased in terms of the global goals. For instance, it is not clear whether the goals *Hurry* means that the student should be provided with guidance or not. The appropriate interpretation depends on other factors such as STUDENT'S ABILITY, which together with it salience (Sa) is used to qualify the extent to which the teacher needs to hurry. The recasting is needed for those local goals which can be paraphrased in terms of the global goals. These include the motivation oriented goals which contribute to the Approval dimension.

Once translated and recast, each goal contributes an equal vote towards the final verdict of whether or not to guide and whether or not to give explicit approval to the student (level seven). Before the final verdict is given by the situational component, the votes are modified by the relevant performance oriented factors which simply means that the votes are qualified by the appropriate factor-value and its salience as to the nature of the final goal and the level with which it applies to a given situation.

In the rest of this section, the individual stages involved in inferring the Autonomy and Approval values from a set of situational parameters are discussed in detail.

6.2.1 Grouping of situational factors

In Chapter 4 a number of situational factors have been identified and their choice was theoretically motivated. In Chapter 5 the nature and the interaction between these factors have been explored and particular groupings of them have been suggested as a

1. **Motivation oriented factors (MOFs)**, which include:
   (a) Student's confidence
   (b) Student's interest
2. **Lesson oriented factors (LOFs)**, which include:
   (a) *Time oriented factors (Tofs)*:
      i. Time left
      ii. Amount of material left
   (b) *Content oriented factors (Cofs)*:
      i. Difficulty of the topic
      ii. Importance of the topic
3. **Performance oriented factors (POFs)**, which include:
   (a) Correctness of student's previous asnwer
   (b) Student's aptitude

Figure 6.3: Three groups of situational factors

result of performing the Principle Component Analysis. For the purpose of the current initial model design, each factor has been defined in terms of two possible, mutually exclusive, states. For example, the factor STUDENT'S CONFIDENCE can be either in the state *confident* or *not confident*, AMOUNT OF TIME LEFT can be either *plenty* or *very little*, etc.

The eight factors currently modelled are divided into three groups (outlined in figure 6.3). The groups reflect the types of situational aspects characteristic to educational situations. While all situational factors affect the values of Autonomy and Approval, only some of them have a direct affect on them.

The specific grouping of the situational factors is motivated primarily by the theoretical considerations outlined in Chapter 4 and by the results of the factor analysis presented in Chapter 5. As will become apparent the grouping is not absolute and some factors, such as student's interest, have a direct[1] impact on the values of Autonomy as well as on Approval.

6.2.1.1 Motivation oriented factors: MOFs

MOFs refer to emotional and motivational states of a student in an educational situation. They lead to actions which the teacher needs to undertake in order to ensure the student's emotional balance, which in turn is to facilitate that student's openness to learning. For example, a student's lack of confidence is an emotional state which may affect his progress negatively. On the other hand, an over-confident student may need "taming" in order to ensure a healthy level of self-satisfaction that will not impair his progress. Similarly, the student's interest depends on his overall emotional balance: if the student does not get rewarded for his achievements, for instance by being praised by the teacher, he may become demotivated. Equally, a student's lack of interest may be the result of his lack of confidence in the form of, say, a fear of failure, or it may result from over-confidence in the form of a dismissive attitude to the material taught, and/or of the learning circumstances. Thus, the student's confidence and interest affect the amount of Approval given to a student directly.

The student's interest also affects the amount of Autonomy that may have to be given to him. On the one hand, a student's boredom may mean that the difficulty of the learning task he is given exceeds his current knowledge and skills. This may make him frustrated with the task affecting the level of his interest in the task. One way to remedy this would be to give the student less Autonomy, by breaking the task into

[1] The distinction between "direct" and "indirect" effect of factors on the two dimensions is such that, although all factors have an impact on the respective levels of Autonomy and Approval by virtue of being part of a given situation only some of them feed directly into the respective dimensions. For example, in the model the level of Approval can only be established reliably based on the salience of confi dence and interest factor, which thereby affect it *directly*. However, the salience of each of the two factors is a result of those factors co-occurring with other situational parameters in a given situation. Therefore the other factors affect the level of Approval given *indirectly*.

smaller, simpler problems and by giving the student plenty of guidance. On the other hand, it may be the case that a capable student looses interest because he is not given enough freedom of initiative. In such a case, the required course of action would be to give the student as little guidance as possible, thus inflating the level of the challenge in support of his independence in learning.

6.2.1.2 Lesson oriented factors: LOFs

LOFs refer to the educational and temporal urgency of a situation, affecting directly the amount of Autonomy, or freedom of initiative that a student may be allowed next. At one extreme they lead to bald actions which, although often regrettable, must be undertaken by the teacher to ensure, for instance, that the student is not falsely believing himself to be on the right learning path. At another extreme, they lead to indirect actions which respect the student's need for Autonomy in exploring the knowledge independently (for example, a teacher may simply ask the student to explain the reasoning that led him to an erroneous answer).

The temporal constraints may affect the Autonomy negatively: lack of time coupled with a large amount of material left to cover in a tutorial may urge the teacher to hurry up, cutting down on the time a student is allowed to explore a topic independently. Similarly, difficulty and importance of the topic may have a negative effect on the level of initiative a student is allowed to have. Depending on a given student's ability, if the task is difficult, for instance, the teacher may decide to give more guidance to the student than if the task were easy. Importance of a topic may affect Autonomy further: a difficult topic which is also crucial may result in a teacher guiding the student more than if the topic were not crucial. LOFs affect the Approval dimension only indirectly.

6.2.1.3 Performance oriented factors: POFs

POFs regulate the decisions that the teacher makes regarding the level of Autonomy and Approval for a given student. This regulatory role is directly linked to the type of information that these factors provide – namely, the information regarding a student's performance. In turn, a student's performance constitutes the most trustworthy measure of a given student's learning gain and of the effectiveness of a given teacher's teaching. POFs are the factors which ultimately affect a teacher's response to a given situation by providing other situational factors, which otherwise could be informationally ambiguous, with a more definitive meaning. Apart from their "managerial" status, the main difference between POFs and the other two groups of factors is that the goals to which they lead are not explicitly represented in the current model. Instead, they affect the estimation of Autonomy and Approval directly. This is not to say that POFs do not evoke goals, instead the goals that they do evoke differ considerably from the ones elicited by MOFs and LOFs.

CORRECTNESS OF STUDENT'S ANSWER gives rise to a general goal: *correct the student* regardless of whether it is in the state *incorrect* or *partially correct*. However the manner in which it is achieved will depend on the states of the other factors which happen to co-occur with it in any given situation. For example, if the student is *incorrect*, *slow* and *not confident* then low Autonomy and high Approval may be evoked, while if the student is *incorrect*, *fast* and *confident* may lead to relatively high Autonomy and relatively low Approval.

STUDENT'S APTITUDE gives rise to a long-term goal of improving or maintaining student's overall performance. In that sense the success of achieving this goal depends on a recurrent success of goals emerging from other situational factors, which may influence performance directly. For example, the speed of the student's progress may be affected considerably by his lack of confidence or interest. In that sense STUDENT'S APTITUDE is a symptom rather than the cause of student's difficulties, and therefore the goals that relate to it can be achieved only via other goals such as boosting student's confidence and interest.

6.2.2 Salience of situational factors

An important facet of the current model, is the intuitively derived assumption that every situational factor has a potential impact on the types of linguistic responses to given situations. However, not all the factors will have an equal impact on teachers' actions: while many different factors contribute actively to a teacher's linguistic choices, only a few are crucial to them in any given situation. The notion of context being subject to prioritisation is motivated by various research such as that on short-term memory and attention, suggesting that in complex situations people can recall, or focus only on the most prominent aspects of those situations (e.g. Baddeley (1990)). The results of the study presented in Chapter 5 further support the interpretation of context as a prioritisable phenomenon. The study shows that the situational factors tested differ with respect to teachers' perception of their individual prominence in each situation, which is further supported by the teachers' comments made after completing the study.

In the current model, the prominence of a factor in a situation is referred to as its *salience*. The salience value of each factor in a particular situation depends on other co-occurring factor instances. For example, in a combination STUDENT CONFIDENCE: *not confident*, TIME LEFT: *plenty*, the first may prove to be more salient than the latter, while in a combination STUDENT CONFIDENCE: *confident*, TIME LEFT: *very little*, the latter may be more salient than the former. In terms of real tutorial circumstances, the first combination means that a student's lack of confidence rather than the fact that there is plenty of time left may determine a teacher's choice of the manner in which to tell the student that his answer is incorrect. In the second combination the decisive factor would be the time left rather than the fact that the student is confident.

As will be illustrated shortly, salience provides the numerical basis for calculating the overall Autonomy and Approval values to which it contributes directly.

6.2.3 Situational Goals

Goals are teachers' specific intentions with respect to whether or not to provide guidance to the student and with respect to whether or not to approve of him. These intentions are referred in the model as *global situational goals.* The global goals divide into two types: GOGs (guidance oriented goals) and AOGs (approval oriented goals). Not all situational factors evoke global goals directly. In the current model only DIFFICULTY OF MATERIAL and IMPORTANCE OF MATERIAL evoke such goals (see figure 6.2 and table 6.1). Other situational factors lead to *local situational goals* which have to be either *translated* or *recast* into the global goals in order to enable the mapping onto the Autonomy and Approval dimensions. There are two types of local goals: MOGs (motivation oriented goals), arising from MOFs (motivation oriented factors) and TOGs (time oriented goals) – a subset of goals arising from LOFs (lesson oriented factors).

6.2.3.1 Translating local goals

The main difficulty with translating the local goals into the global ones is that such translation depends on other aspects of a given situation. For example, it is hard to ascertain whether the TOG: *take time* means that the teacher should give more guidance to the student, because she has the time to do it, or whether she should leave the student to his own devices, because there is no temporal pressure for him to get things right immediately. Using the information about a student's overall progress as the basis for the translation allows for the needed goals to be inferred in a less *ad hoc* manner. In the current model STUDENT'S APTITUDE provides the contextual information necessary for a systematic interpretation of those local goals which are assumed in the model to affect the Autonomy dimension, namely the TOGs: TIME LEFT and AMOUNT OF MATERIAL LEFT, and the MOGs evoked by the STUDENT'S INTEREST. For example, in a situation in which the student's progress is *slow* and the goal is to *take time*, it is likely that the teacher will choose to give the student a relatively high amount of guidance. On the other hand, a student whose aptitude is *high* is likely to be given a

Table 6.1: Inventory of and Rules for Deriving Goals

Situational Factors		**Instances**	**Goals**
MOFs			*MOGs*
1.	Student's confidence:	not confident	Boost Confidence
		confident	Maintain Confidence
2.	Student's interest:	not interested	Boost Interest
		interested	Maintain Interest
LOFs			
			TOGs
3.	Time left:	very little	Hurry
		plenty	Take time
4.	Amount of material left:	a lot	Hurry
		not much	Take time
			GOGs
5.	Importance of material:	crucial	Guide
		not crucial	Don't guide
6.	Difficulty of material:	difficult	Guide
		easy	Don't guide

Table 6.2: Rules for translating TOGs into GOGs

Rule		**Justification**
1.	IF *TOG: hurry* and *slow progress* THEN *Guide* with $N = ((\alpha * S_{apt} + (1-\alpha) * S_{tog}) + 1)/2$ where $\alpha = 0.5$	Given time pressure and the student's low aptitude he may need guidance in order for the current educational goals to be achieved before the time runs out. α of 0.5 indicates an equal impact that the two factors have on the overall Autonomy granted to the student.
2.	IF *TOG: take time* and *slow progress* THEN *Guide* with $N = ((\alpha * S_{apt} + (1-\alpha) * S_{tog}) + 1)/2$ where $\alpha = 0.75$	Given the student's slow progress he may need guidance and given that there is no time pressure the guidance can be provided to him. α of 0.75 indicates that student's slow progress is more important than the lack of temporal pressure.
3.	IF *TOG: hurry* and *fast progress* THEN *Don't guide* with $N = ((\alpha * S_{apt} + (1-\alpha) * S_{tog}) + 1)/2$ where $\alpha = 0.25$	Given the student's fast progress there is probably no guidance needed. The value 0.25 of α signals that the level of Autonomy given may be affected negatively by the temporal pressure.
4.	IF *TOG: take time* and *fast progress* THEN *Don't guide* with $N = ((\alpha * S_{apt} + (1-\alpha) * S_{tog}) + 1)/2$ where $\alpha = 0.5$	Given the student's fast progress and the lack of time pressure there is no need to guide the student. The value α indicates equal contribution by the two factors.

relatively free hand to explore the subject by himself: the combination of *high* aptitude and the goal *take time* allows for the goal *Don't guide* to be inferred.

The rules used to translate the TOGs into GOGs are shown in table 6.2. Apart from being used to translate the local goals in linguistic terms, the rules are also used to calculate the degree to which an inferred goal applies in a given situation. Such calculation is based on the numerically expressed salience that is associated with the performace oriented factor: STUDENT'S APTITUDE (S_{apt}), and with a given local, time oriented goal (S_{tog}). As was explained earlier salience of each factor contributing to a calculation is derived from teachers' ratings of the situational factors (see Chapter 5 for details of the study) and is passed unchanged to the local goals evoked by those factors. Furthermore a general relationship between the factors involved in a calculation is characterised in terms the strength (or weight) of their individual contributions. The individual weights are derived also based on the results of the study in Chapter 5 which show that despite their local importance in a given situation, some factors are generally more important than others.

As is explained in the table, α expresses the relative weight of a temporal goal (i.e., *hurry* or *take time*) and of student's ability (i.e., *slow* or *fast*). Adding 1 to the results of the main calculation and dividing it by 2 is necessary to account for the fact that in all of the four rules in table 6.2, N constitutes only part of the contribution to a given goal. In all those cases N represents the positive contribution to a given goal. For example, in rule 1 N represents a positive contribution to the goal *Guide*. This is indicated by the positive nature of S_{apt} and S_{tog}. However, in the current model, each positive contribution has its negative counterpart. In rule 1 S_{apt} and S_{tog} correspond to the salience associated with *slow* and *hurry* respectively. Given this rule, to calculate the negative contribution to the goal *Guide* (and by virtue of this to calculate the positive contribution to the goal *Don't guide*), S_{apt} and S_{tog} need to correspond to the respective salience of *fast* and *take time* and their contributions need to be signalled with the minus sign. The resulting calculation takes the form as shown in 6.1, where N_{opp} means the opposite of N.

$$N_{opp} = \frac{((-\alpha * S_{apt} - (1-\alpha) * S_{tog}) + 1)}{2} \tag{6.1}$$

Because all the values in the current model fall between 0 and 1, the sum of $N + N_{opp}$ must equal 1. This is also a requirement imposed by the Bayesian Networks method used for implementing the situational part of the current model introduced later in this thesis, in Chapter 7. Although other rules may differ slightly from the ones in table 6.2, the principle behind them is the same. The minus sign signals that the factors contribute to a goal negatively, while a lack of a minus sign indicates a positive contribution, with the sum of all the contributions having to equal 1.

While there is a certain amount of arbitrariness involved in assigning the actual numerical values to α in table 6.2, as well as the values of the individual weights in other rules for combining situational factors, such assignment is intended to be as systematic as possible: the value 0 is used to express no importance of a contributing factor to the overall result, while the value 1 is used to express the absolute importance of a factor. To express less extreme values the range between 0 and 1 is divided into intervals of 0.25. Thus, while an extremely important factor may be given the relative weight of 1, a slightly less, but still very important factor may be given the weight of 0.75, a still less important factor – a weight of 0.5, etc. In the current model no factor is actually given a weight 0, and thus the lowest weight assigned is 0.25. The weights are used to qualify the local importance of individual factors in specific situations as expressed by the salience associated with them. For example, in rule 1 in table 6.2, α is set to 0.5 which means that both the student's slow progress and the teacher's goal to hurry are of equal importance to the overall calculation. In contrast to this, in rule 2 α is set to 0.75 which means that the student's slow progress is more important than the lack of temporal pressure: in this case the factor STUDENT'S APTITUDE contributes three times as much to N as the temporal goal. Ultimately the effect of the individual weights of the contributing factors on the overall result is expressed in the hightened or lowered values of N. While numerically such effect does not tend to be an extreme one, i.e., the value of N tends to be changed by no more than a factor of 0.03, nevertheless when considered together with goals evoked by other situational factors the effect on the values of Autonomy and Approval may be significant enough to lead to a different strategy choice.

The interpretation of the local goals which are evoked by the motivation oriented factor STUDENT'S INTEREST relies on the information provided by the STUDENT APTITUDE factor. Additionally, the interpretation relies on the information regarding the DIFFICULTY OF MATERIAL. For example, if the student is bored, the material is difficult and his aptitude is low then this may indicate that his boredom results from the difficulty of material being set too high relative to his ability. On the other hand, a bored student who is also a capable one may require less guidance and more challenge. In the first case, the combination of student's interest with the difficulty of material and his overall aptitude allows for the global goal *Guide* to be inferred, while in the latter case it leads to the goal *Don't guide*. The rules used to translate MOGs of STUDENT'S INTEREST into GOGs are shown in table 6.3.

6.2.3.2 Recasting local goals

While the local goals evoked by STUDENT INTEREST need to be translated into a guidance goals which can be then mapped onto the Autonomy dimension directly, when interpreted for the purpose of mapping onto the Approval dimension they need to be *recast*. The recasting of a local goal into a global goal simply involves paraphrasing of that goal in terms of an appropriate global approval goal. Because unlike translation, recasting does not depend on any additional situational information, only some goals are eligible for this kind of reinterpretation. In the current model only MOGs are assumed to be suitable for recasting, because their success depends on whether or not a student is given constructive and encouraging performance feedback by his teacher[2]. This, in turn, suggests a natural link between the goal of, say, *boosting confidence* and approving. Thus, in this model *Boost confidence* and *Maintain interest* are recast as the global goal: *Approve*, while *Maintain confidence* and *Boost interest* can be recast as *Don't approve*. It is important at this point to remember that to approve does not

[2]Most prominently, this link is made by Lepper and Chabay (1988). For a detailed discussion of the theoretical motivation as well the role of situational factors the reader is referred to Chapter 4.

necessarily mean to do it explicitly. Approval is any form of acknowledgement on a teacher's part of a student's achievements, or his emotional needs regardless of his accomplishments. Similarly it is important to keep in mind that in the current model not to approve does not mean for a teacher to disapprove of the student explicitly by stating to the student her discontent with him, for example. Instead a teacher may simply withdraw any explicit or implicit form of approval, concentrating on the Autonomy only.

6.2.4 Voting, Modifications and the final Autonomy and Approval values

Once all the local goals are translated and recasted into global goals, the next stage in calculating the Autonomy and Approval values is the process of *voting*. Voting is a way of combining all the relevant global goals together with their salience values which are passed on either unchanged from the corresponding situational factors or they reflect the combination of the salience values of two or more factors. The result of voting consists of two GOGs: *Guide* and *Don't guide*, and two AOGs: *Approve* and *Don't approve*. Each of the goals has a number between 0 and 1 associated with it. The number – the result of combining all of the relevant salience values – expresses the degree to which each goal applies to a given situation. Because the number must fall in the [0,1] range, when a goal is picked its number also defines the degree to which its opposite applies to a given situation. A small number such as 0 means that a given goal is not recommended in a given situation. Such number also informs one that the opposite of the given goal is very suitable for that situation. Similarly a high number such as 1 is a definite confirmation that a goal with which it is associated is a suitable one for a particular situation.

Each of the calculated final goal recommendations is subject to *modification* by one or more performance oriented factor. CORRECTNESS OF STUDENT'S ACTION modifies both the value of the recommended GOG and the value of the recommended AOG. The value of an AOG is modified additionally by STUDENT'S APTITUDE.

Table 6.3: Rules for translating MOGs of STUDENT'S INTEREST into GOGs

Rule	Justification
1. IF *boost interest, difficult material* and *slow progress* THEN *Guide* with $N = (((S_{apt} + S_{diff} + S_{mog})/3) + 1)/2$	The student's boredom may be the result of the material being too difficult relative to his overall ability. The rationale behind the rule is that given the specific factor-values, all of them contribute positively and to an equal extent to the effect of limiting the student's Autonomy by guiding him.
2. IF *boost interest, difficult material* and *fast progress* THEN *Guide* with $N = (((S_{apt} - S_{diff} + S_{mog})/3) + 1)/2$	The student's boredom may be the result of the material being simply too difficult regardless of his high ability. The rationale for the rule is that while both the difficulty and the student's boredom contribute positively to the overall effect of having to guide the student, his relatively high ability does not dictate a complete withdrawal of Autonomy.
3. IF *boost interest, easy material* and *slow progress* THEN *Guide* with $N = ((((S_{apt} - S_{diff} * 0.5) - S_{mog})/2.5) + 1)/2$	The student may need guidance because of his slow progress, but because the student is interested and the material is easy the amount of guidance should be lesser than in case of the rule 1.
4. IF *boost interest, easy material* and *fast progress* THEN *Don't guide* with $N = ((((S_{apt} + S_{diff} * 0.75) - S_{mog})/2.75) + 1)/2$	Given the student's fast progress and easy material, the only sensible way to boost his interest is to allow him more initiative.

5. IF *maintain interest*, *difficult material* and *slow progress* THEN *Guide* with $N = ((((S_{apt} + S_{diff} * 0.75) - S_{mog})/2.75) + 1)/2$	Given student's overall progress and the difficulty of material it may be prudent to give him guidance to keep him interested.
6. IF *maintain interest*, *difficult material* and *fast progress* THEN *Don't guide* with $N = ((((S_{apt} - S_{diff} * 0.5) - S_{mog})/2.5) + 1)/2$	Student's progress coupled with the need to maintain his interest suggests that giving him the initiative could be beneficial to this student.
7. IF *maintain interest*, *easy material* and *slow progress* THEN *Don't guide* with $N = (((S_{apt} - S_{diff} + S_{mog})/3) + 1)/2$	The student may need guidance because of his slow progress, but the amount of guidance should be lesser than in case of the rule 1, because the student is interested and the material is easy.
8. IF *maintain interest easy material* and *fast progress* THEN *Don't guide* with $N = (((S_{apt} + S_{diff} + S_{mog})/3) + 1)/2$	Student's progress and easy material both suggest that to maintain the student's interest is to give him the initiative.

Table 6.4: Rules for modifying GOGs with CORRECTNESS OF S' ANSWER factor

Rule	**Justification**
1. IF *Guide* and *incorrect* THEN *Guide* $N = (((W_{guidance} + S_{corr} * 0.5)/1.5) + 1)/2$	If the outcome of voting is the recommendation to give guidance to the student, then this is supported by the fact that the student gave an incorrect answer. W is the weight with which the results of the voting impact on the final result. In the case of all the rules for modifying GOGs with correctness $W_{guidance} = 1$. The correctness of a student's answer has the weight of 0.5.
2. IF *Guide* and *partially correct* THEN *Guide* $N = (-((W_{guidance} + S_{corr} * 0.5)/1.5) + 1)/2$	If the outcome of voting is the recommendation to give guidance to the student, then this is not supported by the fact that the student gave a partially correct answer. The *minus* sign indicates that the entire rule contributes negatively to the goal *Guide*
.	
3. IF *Don't guide* and *incorrect* THEN *Don't guide* with $N = (-((W_{guidance} + S_{corr} * 0.5)/1.5) + 1)/2$	If the outcome of voting is the recommendation not to give guidance to the student, then this is not supported by the fact that the student gave an incorrect answer. The rule contribute negatively to the goal *Don't guide*.
4. IF *Don't guide* and *partially correct* THEN *Don't guide* with $N = (((W_{guidance} + S_{corr} * 0.5)/1.5) + 1)/2$	If the outcome of voting is the recommendation not to give guidance to the student, then this is supported by the fact that the student gave an incorrect answer.

As a general factor, correctness is the only factor which provides qualifying information with respect to the results of the Autonomy voting. Depending on its current state and its salience, it may either strengthen or weaken a particular GOG recommendation. For example, given the goal is to *Guide* and the correctness of student's action is *partially correct*, then, intuitively, the recommended amount of guidance ought to be reduced to account for the fact that the student managed to get at least part of the answer correctly. On the other hand, if the correctness of the action is *incorrect* then the recommendation to guide the student ought to be supported and the value of the GOG *Guide* should increase depending on the salience of the correctness factor. The rules for modifying GOGs with the information provided by the CORRECTNESS factor are given in table 6.4. The general way in which all of the calculations in the situational component are done involves dividing the results of the calculations in the inner brackets by the total number of the elements contributing to the calculation. For example, in rule 6 in table 6.3, there are two and a half elements contributing to the calculation enclosed in the inner brackets: S_{apt}, S_{diff} and S_{mog} with the first and the last element contributing a full amount and with S_{diff} contributing half of the full amount, given that it is multiplied by 0.5. All of the *minus* signs in the calculations indicate a negative contribution to a given goal by a factor.

Similarly, the result of the Approval voting needs to be qualified by the information provided by the CORRECTNESS factor. Additionally, the interpretation of the voting result relies on the current state of a student's overall aptitude. In this case, the need for including the aptitude information is based on the intuition that in a situation in which a student gives an incorrect or only partially correct answer, a good teacher would seldom rely on the correctness of an individual response to decide whether or not to express her approval of a student. Instead she would make a measured decision regarding the type of Approval suitable for a given student in a specific situation based on the combination of correctness and his overall performance information.

The easiest way to express approval is to praise the student explicitly about his overall achievements or his ability. But in order to be able to approve explicitly, a teacher must be able to identify some positive traits in her student. A student whose

Table 6.5: Rules for modifying Approval votes with S' Aptitude and Correctness of S' answer

Rule	**Justification**
1. IF *Approve*, *slow progress* and *incorrect* THEN *Approve* with $N = (((W_{app} - S_{apt} * 0.25 - S_{corr} * 0.75)/2) + 1)/2$	The student's slow progress and the incorrect answer mean that the teacher has little positive to say about the student's achievements. Yet the student needs to be encouraged somehow. This calls for an implicit form of approving. The recommendation to give approval means that S is either not confident or interested. I either case this means that to avoid discouraging the student his slow progress should have a smaller impact on the overall Approval than correctness.
2. IF *Approve*, *slow progress* and *partially correct* THEN *Approve* with $N = (((W_{app} - S_{apt} * 0.25 + S_{corr} * 0.75)/2) + 1)/2$	The student needs encouragement which could be difficult to give explicitly if it weren't for the fact that the student's answer was only partially incorrect. The fact that a slow student managed to get small part of the answer correctly gives more support to the recommendation for approval than his overall aptitude. Again, in this case the fact the S' answer is partially correct seems more important than his low ability.
3. IF *Approve*, *fast progress* and *incorrect* THEN *Approve* with $N = (((W_{app} + (S_{apt} * 0.5 - S_{corr} * 0.25)/0.75)/2) + 1)/2$	The student needs encouragement and it can be given to him based on his overall performance, hence performance is of greater importance here than the correctness of S' answer. However the incorrect answer means that the force with which the approval is given should be adjusted accordingly.
4. IF *Approve*, *fast progress* and *partially correct* THEN *Don't guide* with $N = (((W_{app} + (S_{apt} * 0.25 + S_{corr} * 0.5)/0.75)/2) + 1)/2$	The student's fast progress and only partially incorrect answer means that the teacher can easily approve of the student in an explicit way. Because the student got part of the answer wrong means that the weight of the contribution to the final amount of approval given should be lesser than that of the S' overall progress.

5. IF *Don't approve*, *slow progress* and *incorrect* THEN *Don't approve* with

$$N = (((W_{app} + (S_{apt} * 0.25 + S_{corr} * 0.5)/0.75)/2) + 1)/2$$

No recommendation not to approve is primarily supported by S' slow progress, but also by an incorrect answer – hence the weight of progress is higher than that of correctness.

6. IF *Don't approve*, *slow progress* and *partially correct* THEN *Don't approve* with

$$N = (((W_{app} + (S_{apt} * 0.5 - S_{corr} * 0.25)/0.75)/2) + 1)/2$$

Although the recommendation not to approve is primarily supported by S' slow progress, the partially correct answer needs to be acknowledged.

7. IF *Don't approve*, *fast progress* and *incorrect* THEN *Don't approve* with

$$N = (((W_{app} - (S_{apt} * 0.25 + S_{corr} * 0.75)/2) + 1)/2$$

Although S' fast progress needs to be acknowledged, the incorrect answer does not support an explicit form of approval. The recommendation of no approval means that the teacher can probably afford to be frank with the student and get on with the lesson.

8. IF *Don't approve*, *fast progress* and *partially correct* THEN *Don't approve* with

$$N = (((W_{app} - (S_{apt} * 0.25 - S_{corr} * 0.75)/2) + 1)/2$$

The recommendation to not to approve means that the student doesn't need overt encouragement. S' fast progress coupled with the partially correct answer means he deserves to be given approval explicitly.

progress is *fast* and interest *high* can be given explicit approval despite the errors in his latest answer. However, in a situation where a student's progress is *slow*, *interest* and confidence are *low* and who has yet again given an *incorrect* answer, a teacher may have a hard time identifying and referring to the student's positive traits. Yet such a student needs to be encouraged in order for his self-confidence and consequently his progress to be improved, and to prevent him from giving up altogether. In such circumstances, and in order to remain truthful to her assessment of the student, a teacher may have to give encouragement implicitly, for example, by offering to solve a problem at hand together with the student (by implying togetherness), or by putting a lot of effort into structuring the problem in a way that may facilitate the students understanding of it. Thus, there seem to be two types of approving:

1. Implicit approving which aims at encouraging the student by scaffolding the task and the feeling of togetherness between the teacher and her student
2. Explicit approving which aims at encouraging the students by rewarding them for their prior or, in the case of partially correct answers, current accomplishments.

One of the main claims of this thesis is that it is possible to characterise situational context in terms of a degree of Autonomy and a degree of Approval appropriate for a specific situation. Furthermore, as will be explained in detail in section 6.3, it is possible to characterise individual language tokens (either individual utterances or multi-sentential moves) in terms of the two numbers referring to the dimensions of Autonomy and Approval. It is therefore required by the model that the two types of approving be reflected in the final Approval value calculated by the situational component based on the results of voting and the relevant correctness and aptitude information. The relation between the explicit and implicit approval and the calculated final value of Approval is such that in a situation which evokes explicit approval, the final Approval value should be higher than that which is evoked by a situation which does not accommodate for explicit form of approval.

Depending on the actual situation and depending on the current salience values of the relevant situational factors, a modification based on the correctness of the student's action and his aptitude should visibly affect the value of Approval. The set of rules which define the way in which such final value is calculated are presented in table 6.5.

As can be seen in table 6.5, the numbers are very precise. The main reason for this is that these calculations are used in the implementation of the model presented in the following chapter. Because the numbers are constrained by the range allowed by the Bayesian Networks used to implement the situational component, namely the range from zero to one, the results of the calculations also need to fall between zero and one. The weights by which the individual factors are multiplied reflect the tendencies expressed by the rules whereby the impact of some factors is greater than other factors which may affect the final result much less, but not always as great as 1.

The interpretation of the final goals in terms of the two dimensions is straightforward. The two GOGs and the two AOGs which result from voting represent the extremes of the Autonomy and Approval dimensions respectively. *Don't guide* and *Approve*, constitute the positive extremes, while *Guide* and *Don't approve* are the negative extremes. In the current model the Autonomy and Approval dimensions are understood in a positive sense: to give Autonomy means *not to guide* which is expressed directly by the GOG: *Don't guide*, while Approval means simply *to approve* and is expressed directly by the AOG: *Approve*. Thus, in order to infer the final values of Autonomy and Approval, the recommended goals need to be exactly *Don't guide* and *Approve* to some degree. The values associated with them express the strength with which they are to be applied to a given situation. For example, a low value of *Don't guide* means that not guiding a student is not only not recommended but that guidance may be a more desirable course of action. Similarly low value of *Approve* means that there is no great urgency in giving the student explicit encouragement.

In the current model the goals are not reconciled in a strict sense of the word; for the Autonomy dimension the goal *Don't guide* will always be chosen. The number associated with it tells one about the force with which it ought to be applied. If the number is small, then effectively this means that quite a lot of guidance should be given to the student. If the number is large – little guidance ought to be given. Finally, if the number is around 0.5, then the goal should be applied with medium force. The same principle applies to the goals *Approve* and *Don't approve,* except that the goal chosen is *Approve*. In that sense neither the Guidance nor the Approval goals respectively are independent from each other in that the salience value of *Don't guide* implies the salience value of *Guide* and, similarly, the salience value of *Approve* informs one about the value of *Don't approve*.

Once the values of Autonomy and Approval are provided by the situational component, the next step is to select the appropriate surface forms from the linguistic component. Each surface form in the linguistic component has $\langle Aut, App\rangle$ value pair associated with it. The way in which these values are assigned to the individual surface forms depends on the strategic system described in the following section. The idea is that for a corrective feedback realisation to be considered a good candidate for a response to a given situation, its $\langle Aut, App\rangle$ values must correspond closely to the $\langle Aut, App\rangle$ values produced by the situational component.

6.3 The Linguistic Component

The purpose of the Linguistic Component is to provide recommendations of the surface forms which are suitable as responses to given educational situations. The process of recommending a form is based on matching the values of Autonomy and Approval which are provided by the situational component with the values associated with specific surface realisations. While such matching is relatively straightforward, the assignment of precise Autonomy and Approval values to individual linguistic forms is not trivial, if it is to avoid being completely arbitrary. The difficulty lies in the lack of a readily available, rational explanation of concrete linguistic forms in terms of precise numerical values. For example, given two surface forms such as *No, this is incorrect, try again* and *Why don't you try again*, it is not immediately clear what should be the basis for assigning a particular set of numbers to the first utterance and a different set of numbers to the latter one. Moreover, the differences between the two forms are not immediately obvious on the intentional level either.

In order to make the coding of surface forms with Autonomy and Approval values more systematic, an intermediate level of representation is needed to provide a way of explaining both the individual $\langle Aut, App \rangle$ values and the differences between surface realisations in terms of their specific communicative and face-oriented functions. In the current model it is the role of the Strategic System to identify and to represent those functions in a way which can be then used to characterise both the numbers and the surface realisations in a common way, and thus to enable the assignment of appropriate numbers to the individual forms. The surface forms which are coded for Autonomy and Approval based on the strategic system are stored in the Surface Realisations sub-component. It is this sub-component which is used to match the $\langle Aut, App \rangle$ values from the situational component and to make final recommendations of the utterances based on the closest matches found. The actual surface forms in the set are a collection of real utterances produced by the tutor in the Pittsburgh dialogues in response to various students' incorrect and partially correct actions or answers.

The term *strategy* is used in the current model to refer to the intermediate level of representation which is necessary to allow for a systematic mapping between the surface forms and the Autonomy and Approval values. Based on Brown and Levinson's proposal (1987), a linguistic strategy is understood here as a speaker's means for satisfying his goals. The term is a useful way of referring to the communicative and face oriented functions of individual utterances.

As has been discussed in Chapter 4, Brown and Levinson derived a system of strategies which they claim is suitable for describing all language with respect to its face oriented aspects. However as was observed in the chapter, this claim is not entirely justified by the linguistic evidence found by various researchers in relation to language in general. Furthermore the claim is not fully supported by the analysis of teachers' language presented in Chapter 3 which was discussed specifically in relation to Brown and Levinson's approach in Chapter 4. The analysis shows that, while some of the relevant linguistic data can be described by Brown and Levinson's strategies, a large proportion of it remains unaccounted for due to some of the strategies being simply unsuitable for the educational domain. However, despite several important problematic aspects of Brown and Levinson's model (see chapters 2 and 4 for detailed discussion and examples of those aspects), their proposal is very attractive not only because it constitutes the most formal system of its kind to date, but precisely because it aspires to a place amongst the universals of language. Since the educational linguistic domain is a sub-domain of language in general, a model of it should also reflect those universals whenever possible. Nevertheless, a system of strategies which would be useful in the educational domain also has to refer to linguistic occurrences which are specific to that domain.

Strategy is also a term used in educational research (Collins and Stevens (1991); McArthur *et al.* (1990)), where it is defined as a teacher's means for attempting to satisfy her pedagogical goals. A pedagogical goal may be to make the student understand a particular aspect of a problem or to teach him a particular skill. Such goals may or may not depend on language use, but in cases where there is such a dependence, a particular teaching strategy used for the purpose of achieving those goals also dictate the type of linguistic choices made by teachers. Although the educational literature does not provide one with a systematic way of referring to the language produced by teachers in terms of teaching strategies, the fact that such strategies often have distinctive linguistic realisations suggests that the two uses of the term strategy are in fact sometimes compatible.

The strategic system presented in this model relies on this compatibility; the system is based on the same formal approach to deriving linguistic strategies as was proposed by Brown and Levinson and uses some of their general categories to characterise those universal strategies which are relevant to education. The system also depends on the input from the educational literature regarding the types of strategies that are used in education (see review in Chapter 2). This means that the strategic component of the model is made relevant to education, while formal linguistic methods for describing language produced by teachers are being used, and while some of the problematic aspects of Brown and Levinson's approach are being avoided. The following sections are concerned with explaining the way in which the strategic system is made relevant to education. They outline the exact methods which are used to build the system and the way in which these methods are the same as, an extension or an improvement of those used by Brown and Levinson. The sections also give a detailed description of every strategy in the system, the situations in which these strategies are typically used are suggested, and the numerical ratings for each strategy are given and justified.

6.3.1 The strategic system

Figure 6.4 shows the overall system of strategies for doing FTAs in an educational context in which a teacher is required to perform a student-corrective action, i.e. respond to a student's incorrect or partially correct answer. While the overall system is explained in detail in subsection 6.3.2, in essence the current strategic system is a catalogue of some of the most relevant means by which teachers tend to achieve their communicative and face oriented goals with respect to students who need to be corrected. The catalogue is based on categorising the teachers' relevant responses found in the dialogues studied, and which findings are related to both the strategies proposed by Brown and Levinson and those proposed by researchers in the field of education and educational psychology (e.g. McArthur *et al.* (1990); Graesser and Person (1994); Graesser *et al.* (1995) and Chi *et al.* (2001)).

On a general level, the current system of strategies is designed to reflect the assumptions stated in Chapter 4, sections 4.3.2 and 4.4. Accordingly, the interpretation of the strategic system currently presented does not rely simply on the appropriateness of a strategy for *lessening* a potential Face Threat of an intended action (as is the case with the Brown and Levinson's model), but on its assessment in terms of a potential risk of leading to actions that are *openly* Face Threatening. Thus, the lower the number of the strategy the higher is the risk of open threat to a student's Face, and *vice versa*, the higher the number of the strategy, the lower the risk of a student's Face being openly threatened.

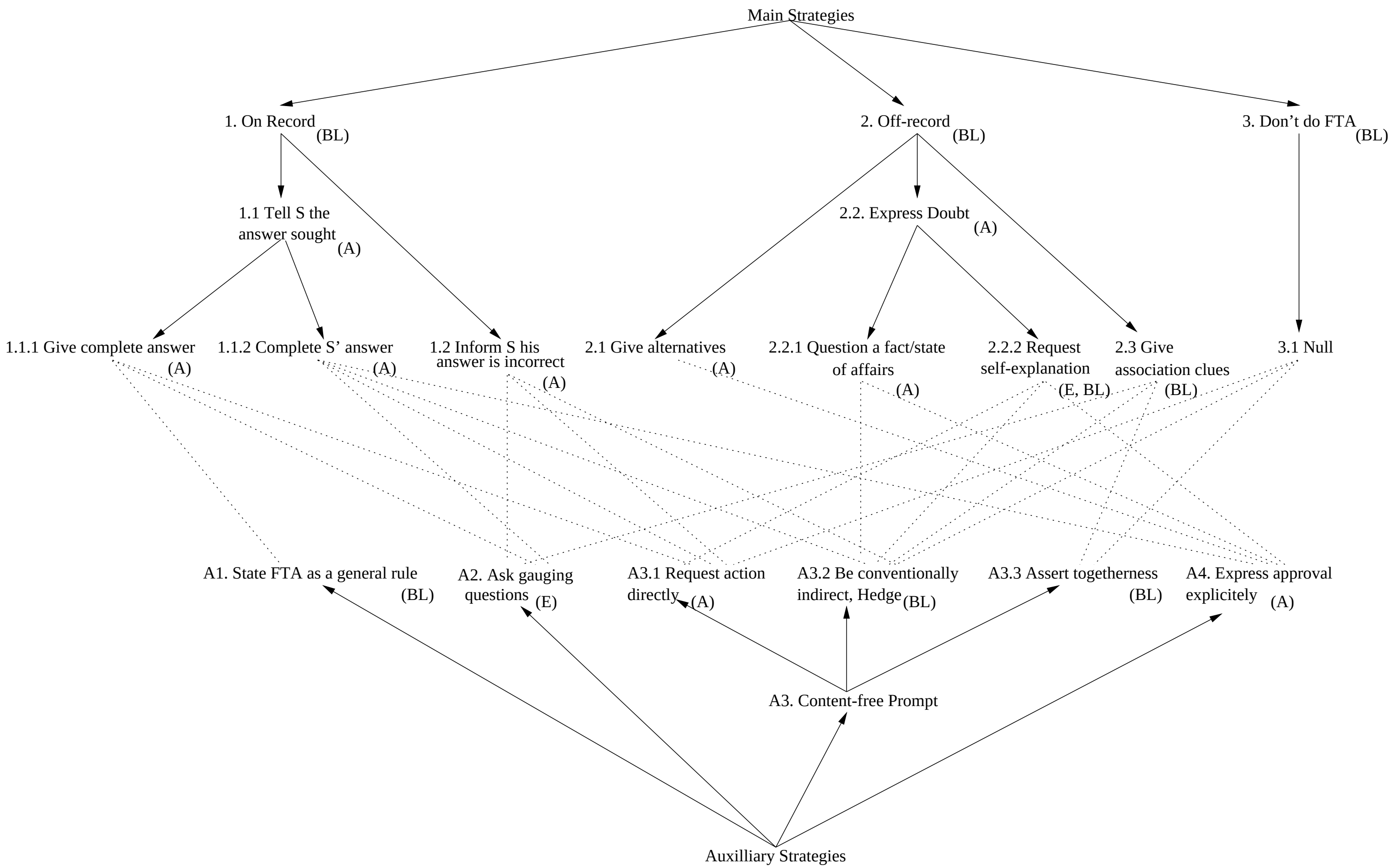


Figure 6.4: Overall Strategic System

6.3.1.1 Method of constructing the strategic system

The selection of the strategies for the current strategic system is based on a semi-formal iterative process involving four cycles. Because Brown and Levinson's approach offers a fully specified system of strategies for doing face threatening actions, it constitutes an obvious starting point for such a selection. In the first cycle, then, Brown and Levinson's strategies are evaluated intuitively with respect to their applicability to the educational context. The results of performing such an intuitive evaluation suggest that while some strategies are suitable for characterising certain types of teachers' utterances, other strategies such as *PP 5 and 6: Seek agreement and avoid disagreement*, *PP 10: Offer promise*, *NP 6: Apologise* or *NP 10: Go on record as incurring a debt, or as not indebting H*[3], do not have an immediately obvious application to education, especially with respect to teachers' language.

The second cycle involves validating the intuitive selection of strategies in the first cycle by considering teachers' real responses to incorrect and partially correct student answers. The validation process consists of finding as many surface forms which could be treated as instances of the selected strategies as possible. The process also involves an attempt at finding the instances of the rejected strategies. The latter is to ensure that no strategy is rejected unjustifiably. The linguistic data is also used to provide clues as to the types of utterances which are difficult to classify according to any of the selected strategies. Only the Pittsburgh dialogues were used formally in the validation in the second cycle. This was because these were the only dialogues at the author's disposal which were formally coded for the correctness of the student's answers. This means that the validation of the selected and rejected strategies is based primarily on the utterances produced by only one tutor. Although the strategic system could be viewed as representing the use of language by that one tutor, as will be discussed shortly, this shortcoming is partly remedied in the third cycle where educational literature, in particular the dialogue analysis by Person *et al.* (1995), is consulted to make the strategic system be more representative of the use of linguistic strategies by teachers

[3]PP refers to Positive Politeness strategy, while NP refers to Brown and Levinson's Negative Politeness strategy. H refers to the hearer.

in general. The Polish dialogues were also consulted in an informal way to provide for a more objective validation of the selected strategies.

The purpose of the third cycle is to identify additional strategic categories. The purpose is also to justify the selected strategies further by referring to the examples of surface forms produced by teachers as documented in the relevant educational literature. The relevant examples were compared to the ones produced by the tutor in the Pittsburgh dialogues. The main changes that this comparison caused involved renaming of certain strategies as well as of re-grouping of some of the surface forms according to the strategies of which they could be instances. The fourth cycle involved using the Pittsburgh dialogues to confirm the selection of the strategies made in the third cycle and to confirm the overall coherence of the strategic system. In figure 6.4, each of the strategies is annotated with letters indicating whether it was originally proposed by Brown and Levinson (BL), educational literature (E), or whether it was invented by the author of this thesis (A).

6.3.1.2 Method of assigning $\langle \mathrm{Aut}, \mathrm{App} \rangle$ to strategies and surface forms

Once a set of strategies relevant to an educational context is established, it is possible to begin to define specific values of Autonomy and Approval with respect to the strategies in the set. Such an interpretation is done on the basis of the respective definitions of the two dimensions given in Chapter 4. In order to enable the assignment of numerical values to the individual strategic categories these basic definitions need further refining. First, they need to provide an explanation of Autonomy and Approval in terms of quantities such as *low* and *high*, and to link these fuzzy terms to specific manifestations of giving low or high Autonomy and Approval, embodied by the individual strategies. Second, the fuzzy quantities need to be translated into concrete numerical values.

In Chapter 4, Autonomy was defined as a dimension of a student's Face which refers to his need to be allowed the freedom of initiative to discover the knowledge by himself. Thus, *to give Autonomy* is interpreted as *to give the freedom of initiative to the student* and consequently – to provide him with as little guidance as possible. As

Table 6.6: Correspondence between different levels of Autonomy and concrete numerical ranges

Type of Aut	**Fuzzy Range**	**Numerical Range**
Plenty of guidance	low-medium	0 – 0.45
Medium amount of guidance	medium	0.45 – 0.55
Little guidance	medium-high	0.55 – 1

was explained in section 6.2.4, the tendency to allow the student the initiative whenever possible is characterised in the model by the guidance oriented goal GOG: *Don't guide*. Thus, *not to guide* means to provide the student with as little information regarding the answer sought as possible, be it in the form of actual answer or in the form of a highly structured, leading question. Autonomy with a *high* number associated with it is interpreted as giving away little information, while a *low* number implies plenty of guidance and plenty of information being given to the student. It is assumed here that the lowest possible value is 0, while the highest possible value is 1. The values below 0.45 represent the lower range and thus they imply a low to medium amount of Autonomy, the values between 0.45 and 0.55 refer to a medium amount of Autonomy, while the numbers between 0.55 and 1 refer to medium to high Autonomy. These divisions are summarised in the table 6.6.

The definition of Approval in Chapter 4 states that Approval is a dimension of a student's Face which refers to the student's need for his positive self-image to be maintained. Furthermore the definition states that a student's positive self-image relies on his confidence and interest being maintained or boosted. The definition is refined based on recasting of the MOGs: *boost confidence/interest* and *maintain confidence/interest* in terms of the approval oriented goals (AOGs). Thus, because *boost confidence* and *maintain interest* lead to the goal *Approve*, they will also lead to explicit Approval, while *maintain confidence* and *boost interest* will lead to implicit, or no Approval at all.

Table 6.7: Correspondence between different levels of Approval and concrete numerical ranges

Type of App	**Fuzzy Range**	**Numerical Range**
No Approval	low	0 – 0.25
Implicit Approval	medium	0.25 – 0.55
Explicit Approval	high	0.55 – 1

The current model does not account for explicit disapproval based on the assumption that teachers are explicitly disapproving only in disciplinary situations not considered here. In terms of numerical ranges explicit Approval is coded by the high to medium range (0.55 – 1), implicit Approval is represented by the values between 0.25 and 0.55, while no Approval is expressed by the numbers between 0 and 0.25. These numbers are summarised in the table 6.7.

The assignment of specific numbers to individual strategies is done by examining each strategy in general terms with respect to the level of Autonomy and Approval that it seems to express. The result of such an examination is the assignment of a range of values that intuitively describes those levels the best. Next, the strategies are compared with one another to ensure coherence in the way that the values are actually assigned. Tables 6.8 and 6.9 respectively show the main strategies in the ascending order from the lowest to the highest level of Autonomy and Approval. Similarly tables 6.10 and 6.11 show the auxiliary strategies also ordered from lowest to highest values. It is important to bear in mind that the ordering is not absolute as more than one strategy could be assigned to the same position in a given continuum. For example, *Give alternatives, Question a fact/state of affairs* and *Give association clues* could be placed in any order between the positions 2 and 5 depending on their exact interpretation – (see further section for an explanation). Also in case of the main strategies their place can be altered depending on the type of auxiliary strategy with which they happen to combine for the purpose of a particular linguistic response.

Table 6.8: Main strategies ordered according to the amount of Autonomy that they express.

Lowest Autonomy

Strategy ID	Strategy name
1.1.1	Give complete answer
1.1.2	Complete student's answer
2.1	Give alternatives
2.2	Question a fact/state of affairs
2.4	Give association clues
2.3	Request self-explanation
1.2	Inform the student that his answer is incorrect

Highest Autonomy

Table 6.9: Main strategies ordered according to the amount of Approval that they express.

Lowest Approval

Strategy ID	Strategy name
1.1.1	Give complete answer
1.2	Inform the student that his answer is incorrect
1.1.2	Complete student's answer
2.2	Question a fact/state of affairs
2.3	Request self-explanation
2.1	Give alternatives
2.4	Give association clues

Highest Approval

Table 6.10: Auxiliary strategies ordered according to the amount of Autonomy that they express.

Lowest Autonomy

Strategy ID	Strategy name
A3.1	Request action directly
A1	State FTA as a general rule
A3.3	Assert togetherness
A3.2	Be conventional indirect, hedge
A2	Ask gauging questions
A4	Express approval directly

Highest Autonomy

Table 6.11: Auxiliary strategies ordered according to the amount of Approval that they express.

Lowest Approval

Strategy ID	Strategy name
A3.1	Request action directly
A1	State FTA as a general rule
A2	Ask gauging questions
A3.2	Be conventional indirect, hedge
A3.3	Assert togetherness
A4	Express approval directly

Highest Approval

Since each strategy is validated during the selection process by the real linguistic data, by the end of the fourth cycle of deriving the strategic system, all the surface forms in the Surface Forms set are already grouped according to the strategies of which they can be instances. Unless additional surface forms are added to the set no additional grouping is necessary. In order for the concrete Autonomy and Approval values to be assigned to individual surface forms, the forms need to be compared to other forms in the group and they need to be ordered (in a similar way as the strategies were ordered) according to the part of the numerical range associated with their strategy that characterises them best.

In the following subsections the main divisions within the strategic system are discussed, each of the available strategic choices is examined in detail with respect to how they affect the assessment of the corresponding surface forms in terms of the Autonomy and Approval dimensions, examples of the corresponding surface realisations are given, and the key situational factors relevant to an application of every strategy are suggested.

6.3.2 Overall structure of the strategic system

At the highest level of interpretation, the strategies shown in figure 6.4 are divided into two groups: the group of main strategies which represent the primary choices for a teacher's responses to students erroneous actions (top part of the diagram), and the group of auxiliary strategies which are used to modify the main strategies in terms of the degree to which they are Face threatening. Except for the strategy *A2 Ask gauging questions*, which is referred to in the educational literature (e.g. Chi *et al.* (2001)), the auxiliaries correspond to Brown and Levinson's redressive strategies (2 and 3), in which Positive and Negative Face are addressed explicitly for the purpose of softening the blow of the Face threatening acts associated with them. In that sense the auxiliary strategies cannot occur by themselves, but instead are always accompanied by one or more main strategies. The top-level main strategies also correspond to Brown and Levinson's *Bald, On-record*, the *Off-record* and the *Don't do FTA* strategies respectively. At this level the model assumes the same distinction between direct (on-record) and indirect (off-record) actions that a teacher may undertake, as is assumed by Brown and Levinson in general language use. These top-level strategies refer to the two universal modes of language use which is characteristic of all linguistic domains (Brown and Levinson, 1987).

The current strategic system differs in two main respects from that proposed by Brown and Levinson. The two differences are in the interpretation of the roles that the individual strategies play in the system. The first difference concerns the top level strategy *Don't do FTA*. In the current system the interpretation of this strategy relies on the observation that often people do not realise their actions overtly. Instead, some actions can be implied by a context or by other linguistic means. Specifically in the educational contexts studied here in which a student needs to be corrected, the teacher may choose not to use the utterance: *No, that's incorrect*, for example. Instead she may simply say: *Try again*, thereby implying that whatever the student did or said did not constitute a desirable answer. As will be explained in more detail in the following sections, the implicature of the overt act is treated in the current system as a non-overt FTA, or an FTA that has not been explicitly performed. On the other hand, Brown and Levinson's interpretation of this strategy is that an act is simply not performed as if it has never been intended in the first place, and therefore that it leaves no traces be it in the form of implicatures or other ones.

The source of the second difference is two-fold. First, there is a problem with the way in which Brown and Levinson treat all of the strategies as being of the same communicative importance. The main reason for claiming such equality in Brown and Levinson's model is their *BL's Assumption 1*, which states that *the strategies for doing FTAs are by nature designed to provide a way of avoiding threat to other people's Faces*, and thereby that the application of any of such strategies represents the optimally polite way of communicating. This is problematic, because as was discussed in Chapter 4, it is often the case that to be bald and on-record is to be more polite and respectful to others than to be indirect and redressive – a facet of politeness which Brown and Levinson recognise without accounting for it in any specific way.

The second problematic aspect of their proposal is the distinction that they make within the redressive strategy between Positive and the Negative politeness strategies. At least in an educational context, this distinction is difficult to justify because the same type of redress may address both Faces simultaneously. For example, a direct request for further action such as *Try again* may be interpreted as a sign of encouragement for the student to carry on (Approval by virtue of making the effort to request further action) and as restricting the student's Autonomy, by virtue of telling the student what to do next.

The consequence of the first observation to the current strategic system is the split between the main and the auxiliary strategies, in which the latter perform a modifying role with respect to the main strategies. In that sense they correspond to what Fetzer (2003) refers to as *additional language*. This allows for a more flexible strategic system than that proposed by Brown and Levinson which addresses the issue of some of the bald strategies being more suitable in certain situations than the redressive or the off-record ones. In the current system, all of the main strategies are threatening to some degree and are used to express the main message of an action, but, if required by a given situation, the actual degree of threat that they express can be modified, i.e., it can be either raised or lowered, by the auxiliary strategies. The auxiliary strategies are independent of the main strategies in that they can be characterised independently in terms of the Autonomy and Approval values. They do not represent only the redressive strategies classified by Brown and Levinson. Instead, they are a collection of different ways in which the teachers in the Polish and the tutor in the Pittsburgh dialogues used additional language to soften or to strengthen the main messages of their linguistic acts.

The consequence of the second observation is the lack of a distinction being made in the current system between those redressive strategies which address Positive Face and those which address Negative Face. Thus, each strategy in the system can be characterised in terms of both dimensions of face simultaneously.

Ultimately, the model presented in this thesis assumes that the purpose of Brown and Levinson's on-record redressive strategies is of auxiliary, modifying nature. More precisely, it is to rectify or to remedy a Face threat expressed by an accompanying main act which conveys the main message of the overall action.

A single linguistic act may be the product of at least one or more main strategies and at least zero or more auxiliary strategies. When an act is evoked by one main strategy and zero auxiliary strategies, such an act is referred to as a *simple* act (example 6.2(a)). When an act is produced by one or more main strategies and one or more auxiliary strategies such an act is referred to as a *complex* act (example 6.2(b)). Moreover a single auxiliary strategy may combine with another auxiliary strategy to produce a *complex auxiliary*(example 6.2(e)). A main strategy which does not have an overt realisation is assumed to be the product of the *Don't do FTA* strategy. In the current model, this assumption is only valid if an act appears to be an overt realisation of zero main strategies and one or more auxiliary strategy (example 6.2(c)). Such an act is classified here as a complex act. If an act is in some way an overt realisation of at least one main strategy and one or more auxiliaries (example 6.2(d)), this assumption cannot be made.

(6.2)

(a) That's incorrect.

$_{main1.2}$[That's incorrect]

(b) You're getting close, but that's still incorrect.

$_{auxA4}$[You're getting close] $+_{main1.2}$ [that's incorrect]+ $_{auxA3.2}$[but] $+_{auxA3.2}$[still]

(c) Try again.

$_{\o main1.2}$[*That's incorrect*] $+_{auxA.3.1}$ [Try again]

(d) No, try again.

$_{main1.2}$[No] $+_{auxA.3.1}$ [try again]

(e) We are running out of time. The answer is X.

$_{auxA3.3}$[We]$+_{auxA1}$[there isn't anymore time left] $+_{main1.1.1}$[The answer is X]

The analysis of the Pittsburgh dialogues suggests that the complex strategies can be realised either by acts which consist of a single sentence, or they can be multi-sentential in nature. Educational dialogue analyses by other researchers exemplify a similar phenomenon (in particular Person *et al.* (1995)). This raises a question regarding the way in which such complex acts can be assessed in terms of the Autonomy and Approval dimensions. In particular, should there be only one Autonomy and one Approval value for the entire multi-sentential act or should the act be characterised in terms of several $\langle Aut, App \rangle$ value pairs corresponding to the individual main strategies involved?

The answer to this question adopted in the current model is the following. Each act, multi-sentential or not, is characterised in terms of a single $\langle Aut, App \rangle$ value pair. This decision is driven primarily by the observation that such acts are not interrupted in any way by students' responses or actions and as such they are (a) responses to the same previous action of a student, and (b) they are aimed to have a combined communicative and face-oriented effect on the student[4]. Thus the approach to treating such complex strategies in the current model is to characterise them in the same way as the simple strategies using just a single $\langle Aut, App \rangle$ pair of values. In order to reflect the complexity of the language produced as a consequence of multiple strategies being used, the assessment of the Face Threat of the resulting action relies on a function which combines the independent values of Autonomy and Approval for the strategies involved.

The function used relies on three assumptions. First, it is assumed here that in calculating the Autonomy value of surface forms which are not the product of the main strategy *Don't do FTA*, the auxiliary strategies carry half as much weight as the main strategies do; in an educational context the main purpose of the auxiliaries is to

[4]The (informal in this respect) dialogue analysis suggests that such complex acts may be a result of a teacher's repairing what she might perceive as not exactly an appropriate or optimal first attempt at responding to a student's previous action. In this case, it is subject to further investigation whether or not a computer tutor ought to mimic this kind of linguistic behaviour. This issue can only be resolved based on thorough analysis of dialogues aimed at examining the circumstances and the possible reasons for a teacher using these kind of hybrid strategies, and on the evaluation of student's learning gains given the application of such strategies *versus* less complex modes of communication – neither of which issues is investigated in the current work.

address the student's need for Approval and therefore their contribution to the degree of Autonomy that is eventually given to the student is lesser. However if the surface form is the product of the *Don't do FTA* strategy, the auxiliary strategies used to produce the overt act contribute a full amount, i.e. their weight is 1. This is because, arguably, an overt realisation of an act has a more powerful effect than a (weakly) implied one with no overt manifestation. Second, when calculating the Approval values of surface forms, the auxiliary strategies contribute as much to such an assessment as the main strategies do. Third, while the *On-record* and the *Off-record* strategies involved in producing an act are equally important, the *Don't do FTA* contributes only half of the overall weight by virtue of not having an overt realisation.

Given these three assumptions the function which is used to combine the individual Autonomy and Approval values of the strategies involved is simply the weighted mean equation 6.3. For Autonomy the weight of the main strategies is 1, while that of the auxiliaries is 0.5. The resulting Autonomy and Approval values for the compound strategies depend on two sets of input values: the independent values for Autonomy or Approval of the main strategies and the independent values for Autonomy or Approval of the auxiliary strategies. The resulting values correspond to a particular surface realisation resulting from an application of a complex strategy.

$$autonomy|approval = \frac{\sum_{i=1}^{n}(main_i * mainW_i) + \sum_{i=1}^{m}(aux_i * auxW_i)}{\sum_{i=1}^{n} mainW_i + \sum_{i=1}^{m} auxW_i} \tag{6.3}$$

Where for *aut*: $mainW_i = 1$ for main strategies 1 and 2, but $mainW_i = 0.5$ for the main strategy 3; $auxW_i = 0.5$ if it appears together with the main strategies 1 and 2, but $auxW_i = 1$ if it happens together with the main strategy 3. For *app*: $mainW_i = 1$ for main strategies 1 and 2, but $mainW_i = 0.5$ for main strategy 3; $auxW_i = 1$ if it appears together with any three main strategies.

The formula is used for calculating both (or either) Autonomy and Approval values. $mainW_i$ means the weight of the contribution by the main strategy i, while $auxW_i$

means the weight of the contribution by the auxiliary strategy *i*.

6.3.3 The auxiliary strategies

As shown in figure 6.5, the set of redressive, auxiliary strategies consists of six sub-strategies, of which A1, A3.2, A3.3 and A4 correspond to some of the positive and negative politeness strategies proposed by Brown and Levinson. Strategies A2 and A3.1 along with the super-strategy A3 are specific to the current model and were motivated by the linguistic data analysis (Chapter 3), and by observations by other researchers (e.g., Chi *et al.* (2001)) of the type of linguistic patterns occurring in teachers' use of language.

The dialogues suggest that there are specific patterns regarding the type of the main strategies with which the auxiliary strategies tend to combine. These restrictions are explored in detail in the following sections. The possible combinations are illustrated in figure 6.4 by means of dotted arrows, which should be treated as indications rather than as requirements or restrictions.

The ratings of the strategies are relative to other strategies in the same category. Thus, all the auxiliary strategies are rated in terms of Autonomy and Approval with respect to each other. Similarly, the values that are assigned to the surface forms within each strategy are assigned in a comparative way. Table 6.13 shows the overall ratings of the strategies and a break down of Autonomy and Approval values for individual example surface forms. The following subsections discuss the reasons for particular value assignments and suggest situations in which each strategy may be used in a typical way.

6.3.3.1 Strategy A1: State FTA as a general rule

Brown and Levinson observe that people often turn their requests for favours or actions on the part of others into general rules. These rules assert commonness or universality of the requests and of the relevant expectations of fulfilment associated with them,

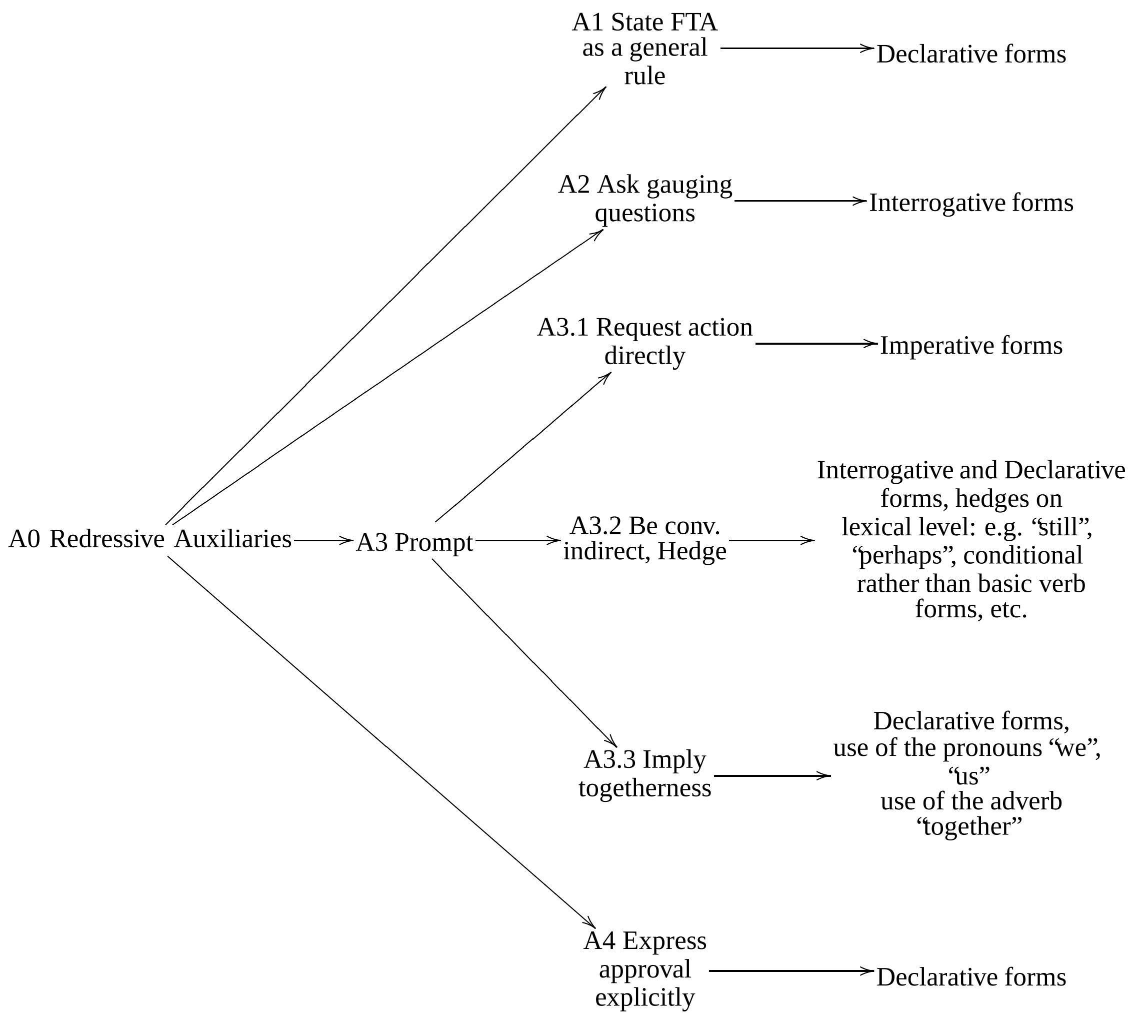


Figure 6.5: Redressive, Auxiliary Strategies

Table 6.12: Strategies ordered from lowest to highest Autonomy rating and example surface forms

Lowest Autonomy

Strategy ID	**Strategy name**	**Rating**	**Example SF**	**SF Rating**
A3.1	Request action directly	0	*Try again* *Look at it once more* *Do it again*	0 0 0
A1	State FTA as a general rule	0.1	*There isn't any more time left.* *We are running out of time*	0.1 0.1
A3.3	Imply togetherness	0.3–0.4	*Let's do it step by step* *We, us* *Let's do it together*	0.3 0.4 0.4
A3.2	Hedge, Be conventionally indirect	0.3–0.8	*actually* *but, and* *Why don't you try to do it?* *Do you want to try it?* *Perhaps you should try it.* *still, perhaps, well, maybe*	0.3 0.4 0.6 0.7 0.5 0.8
A2	Ask gauging questions	0.7	*Do you understand this now?*	0.7
A4	Express approval directly	1	*Excellent!, Very good, Great* *You're getting there...* *good, close-but..., fi ne, OK, you're right about X- but...*	1 1 1

Highest Autonomy

Table 6.13: Strategies ordered from lowest to highest Approval rating and example surface forms

Lowest Approval

Strategy ID	**Strategy name**	**Rating**	**Example SF**	**SF Rating**
A3.1	Request action directly	0	*Try again*	0
			Look at it once more	0
			Do it again	0
A1	State FTA as a general rule	0.3–0.45	*There isn't any more time left.*	0.3
			We are running out of time	0.45
A2	Ask gauging questions	0.4	*Do you understand this now?*	0.4
A3.2	Be conventionally indirect,	0.55–0.7	*actually, but, and*	0.3
			still, perhaps, well, maybe	0.55
	Hedge		*Perhaps you should try it.*	0.6
			Do you want to try it?	0.65
			Why don't you try to do it?	0.7
A3.3	Imply togetherness	0.6–0.8	*We, us*	0.6
			Let's do it step by step	0.7
			Let's do it together	0.8
A4	Express approval directly	0.8–1	*good, close-but..., fi ne,*	0.8
			You're getting there...	0.9
			OK, you're right about X- but...	
			Excellent!, Very good, Great	1

Highest Approval

thereby reducing the speaker's responsibility for imposing on the hearer. In educational situations there is one particular scenario which makes this strategy a natural choice for a teacher, namely when there is no more time left to continue the lesson and the topic is important enough for the teacher to have to tell the student the answer sought. This strategy is typically realised by declarative surface forms such as: *We are running out of time, so I'll tell you the answer*. On the lexical level the strategy makes use of either the personal pronoun *we*, or it impersonalises the generalisation: *There isn't any more time left,....* The use of the personal pronoun may be interpreted as aimed at a more approving effect than the effect of impersonalisation. This is achieved by means of the teacher including herself in the situation with the student, thereby implying a state of togetherness and combined responsibility for not achieving the educational goals in the most desirable manner which is to let the student discover the answer independently. When the personal pronoun *we* is used this strategy becomes a complex auxiliary strategy by virtue of combining with the strategy A3.3 of which the characteristics are discussed in subsection 6.3.3.3.3.

As can be seen in figure 6.4, this strategy has a limited application as it only combines with the strategy *1.1: Tell the student the answer sought*, which expresses the lowest regard for Autonomy of all the strategies in the system (see discussion of on-record strategies). Because this strategy leads inevitably to the actual answer sought, its Autonomy value is low (0.1), but because it does not in itself give the answer away, and thus theoretically leaves the scope for a student to protest against such an action, it is not as low as 0. The rating of this strategy on the Approval scale is slightly higher than that of Autonomy – between 0.3 and 0.45, depending on whether or not a personal pronoun is used. When a personal pronoun is used the value 0.45 is assigned to the corresponding form. This value is the result of combining the basic Approval value 0.3 of this strategy and the lowest value of Approval for strategy A3.3 which is 0.6. The values 0.3–0.45 places this strategy within the implicit Approval range, with 0.3 being the lowest in the range and expressing relatively little approval, and 0.45 being closer to the top end of the range and accounting for an increase in the explicitness of the Approval expressed (the pronoun *we*). For a reminder of the relevant scales the reader is referred to tables 6.10 and 6.11.

6.3.3.2 Strategy A2: Ask gauging questions

Gauging questions represent a specific educational method for checking a student's understanding of a particular point or concept which typically is either explained to him by the tutor prior to the question being asked or it is expected to be understood because the student has performed an action which should have explained it to him. The surface forms which correspond to this strategy are the interrogative forms such as *Do you understand this now?, Can you see now how this works?,* etc. As Chi *et al.* (2001)) point out, gauging questions are not a form of diagnostic evaluation by a teacher of how much the student knows, but a way of *prompting* the student's self-report. As such the strategy impinges on the student's Autonomy only in so far as it is not letting the student provide the self-report out of his own initiative. On the other hand, this strategy does not in itself give any information away, nor does it structure the reasoning for him. By virtue of this, with the value 0.7 it rates relatively high on the Autonomy scale. However, this strategy combines in a systematic way with the main strategies which do give answers away to the student or which may involve a lot of structured hinting or giving association clues (i.e., strategies which rate low with respect to Autonomy).

The value of Approval is 0.4, which expresses implicit Approval by virtue of not involving an explicit Approval giving in the form of a direct praise or encouragement. The value is not the lowest possible in the implicit approval range because its use indicates a teacher's general involvement in student's learning. However, although the implicit approval expressed by this strategy is higher than the impersonalised use of the strategy A1, it is lower than the personalised use of A1.

6.3.3.3 Strategy A3: Content-free prompting

Prompting is a complex notion and many researchers in educational interaction have proposed various ways in which to interpret it. The general interpretation of prompting is that it is a form of encouragement given to the student to carry on with the task at hand. However, this interpretation is inadequate given the extent of different ways in which a teacher can encourage the student. Amongst the many interpretations, there is a general suggestion made by Chi *et al.* (2001) that prompting loosely divides into content-free and scaffolding (or content-oriented) encouragements. Thus the strategy currently investigated belongs to the first type, while the main off-record strategies may be seen as corresponding to the latter category of prompting. As the name of the strategy suggests, there is no content involved in this strategy, i.e. neither does the teacher state the answer sought nor does she evoke it from the student. Instead, the direction of the next action required by the teacher from the student is made obvious to him, hence by default impinging on student's initiative.

6.3.3.3.1 Sub-strategy A3.1: Request action directly The direct requests for actions are typically expressed by means of imperative forms such as *Try again*, *Look at it once more...*. This auxiliary strategy is usually found in situations where the student is incorrect (as opposed to partially correct) and confident enough to be given unceremonious instructions. This strategy tends to combine with both of the main on-record strategies: *1.1 Give complete answer* and *1.3 Tell the student his answer is incorrect* as well as with the most structure-giving strategy: *2.4 Give association clues.* This strategy gives no Autonomy to the student, because it deprives him from the possibility of making an independent decision to undertake an action. As a consequence it scores 0 on the Autonomy scale. Also in terms of the amount of Approval this strategy scores low: there is no overt Approval expressed by its means, and even if one were to interpret it as an honest encouragement on the teacher's part, its abrupt nature suggests the lowest possible value: 0.

6.3.3.3.2 Sub-strategy A3.2: Be conventionally indirect Conventional indirectness is usually associated with *polite* requests such as *Could you pass the salt, please?*, whereby the speaker does not really question the hearer's ability to pass the salt, but rather uses a socially conventional way of asking for salt. Brown and Levinson treat conventional indirectness as one of the most obvious and well established ways, within the English speaking societies, of reducing the rank of imposition on the person from whom the favour was requested (in the current example the favour of passing of the salt). There are various ways in which conventional indirectness may manifest itself in terms of surface forms. One of the most common forms is the interrogative form which questions either a hearer's ability to perform an action or questions the reasons for which a hearer could not or would not perform an action, thereby expressing a wish for the hearer to perform that action. The latter form is found commonly in the Pittsburgh dialogues[5], e.g. *Why don't you try it again?*. Depending on whether an indirect request or a hedge is used, the Autonomy score may vary between 0.5 for the conventional indirectness and 0.8 for a simple hedge such as *still*, *perhaps* or *Well*. While the latter have little effect on limiting a student's Autonomy, the first is an instruction for a student to perform an action and thus has similar educational implications as the application of the direct request strategy A3.1. However, because the request is indirect, it leaves the scope for a student to act differently than to perform the requested action and even leaves him the scope of not performing the action at all. This is why this strategy rates higher on the Autonomy scale than strategy A3.1.

Similarly, depending on whether a hedge or conventional indirectness is used, the value of Approval may vary between 0.3 for hedges and 0.7 for indirect requests. While hedging is a step in the direction of explicit Approval it is still implicit in nature. On the other hand the use of an indirect speech act is a form of explicit Approval especially when contrasted with direct requests, and hence the value falls within the explicit Approval range.

6.3.3.3.3 Sub-strategy A3.3: Imply togetherness Asserting togetherness is yet another way of instructing the student to perform an action, without being unceremonious. Of all the prompting strategies, this strategy scores the highest in terms of Approval: between 0.6–0.8 , even though in terms of Autonomy with its highest value of 0.4, it scores lower than the strategy A3.2. This strategy combines with the off-record main strategy *2.4 Give association clues* and may be applied either by means of entire sentences, e.g. *Let's look at it together*, or in terms of specific lexical choices

[5]Polish dialogues show slightly different patterns: conventional indirectness not only manifests itself differently, but also its application is conditioned by different social aspects than is the case in English. When prompting, Polish teachers tend to use direct requests or instructions – a socio-linguistic difference of which the investigation is not pursued in this thesis.

in the form of the third person, plural pronouns (*we, us*) or possessives (e.g *our*). The middling Autonomy value in comparison to the other two prompting strategies is due to the fact that while implying togetherness does not limit student's initiative to the same extreme extent as strategy A3.1, it nevertheless does not give the student the option of not performing a task at hand or allowing him to undertake it out of his own accord. On the other hand, in terms of Approval, the strategy appears very close to expressing it directly and hence the relatively higher values. The different Approval values are assigned depending on the total number of togetherness markers in a single form. The situations in which this auxiliary strategy may be applied typically involve a student lacking in confidence, a relatively difficult and (optionally) an important topic.

6.3.3.4 Strategy A4: Express Approval directly

To express Approval directly means to give it explicitly. This leads to the highest possible values for Approval: 0.8 to 1.0, depending on the nature and number of superlatives used by the teacher (e.g. the word *fine* is less approving than *good*, which in turn is less approving than *very good*, *great* or *excellent*), the amount of personalisation and the actual Approval ratings of the main strategy with which it happens to co-occur. Similarly, the Autonomy rating 1 is the highest possible. The reason for this rating is the fact that the directly approving strategy does not impinge in any way on student's freedom of initiative; if anything, it suggests that the student's performance was adequate and that he can be allowed to explore a topic independently. However, in the student-corrective contexts considered here, this strategy tends to combine with low Autonomy main strategies such as *1.2 Complete student's answer*, *2.2 Question a fact/state of affairs* and *2.4 Give association clues*. The surface form of Explicit Approval is either an exclamative form such as *very good*, *Excellent*, or a declarative form such as *You are right about...*.

In terms of the situations in which this strategy tends to be used, typically the key factor is that of the correctness of the student's answer which must be in the state: *partially correct*. This is the typical scenario in that most explicit approvals refer to the student's achievements which immediately preceded or formed part of his partly erroneous answer. Thus, the general situation which allows a teacher to apply this strategy is the existence of anything positive to be said about the student and his progress. It is possible for this strategy to be used in cases when the student is actually completely incorrect. Such application usually involves the assessment of the student's general progress and hence it depends on the *student's aptitude* factor, as well as possibly being conditioned by the student's low confidence.

6.3.4 On-record strategy

From the perspective of a speaker, including a teacher-speaker, the simplest linguistic choice that a person can make is that which allows her to get straight to the point by using the least possible effort. A strategy which corresponds to such a choice is the *on-record* strategy. In general, and in agreement with Brown and Levinson's proposal, this strategy relies on observing the four Conversational Maxims listed in section 4.4. Such observance carries the promise of a truthful, concise and perspicuous action devoid of any unnecessary extras and communicative ambiguities. The non-observance of any one of the Maxims leads to a different strategy which deviates from communicative efficiency sought by the on-record strategy.

In contexts requiring student-corrective actions, this strategy, more often than not, leads to actions which are openly Face threatening. This is why generally, it does not present itself as a first choice to teachers. There are however two scenarios in which a teacher may choose to use this strategy:

1. The teacher is running out of time.
2. The student's progress is persistently slow.

In general the on-record strategy affects both Autonomy and Approval dimensions. In the most extreme cases, it deflates to a minimum the amount of Approval given to a student, and takes the initiative away from him. Figure 6.6 details the choices of on-record sub-strategies available to a teacher and their typical surface realisations. Note

Table 6.14: On-record strategies ordered from lowest to highest values of Autonomy and example surface forms

Lowest Autonomy

Strategy ID	Strategy name	Rating	Example SF	SF Rating
1.1.1	Give complete answer	0	*The answer is ...*	0
1.1.2	Complete S' answer	0	*No, 10 or less* *10 or less* *Yes, 10 or less* See the context of the utterance in subsection 6.3.4.1.2	0 0 0
1.1.3	Inform S his answer is incorrect	1	*No, that's incorrect* *That's incorrect* *No*	1 1 1

Highest Autonomy

that the possible combinations with the auxiliary strategies are also shown in the figure. Table 6.14 and 6.15 show the ratings of the individual on-record sub-strategies in terms of Autonomy and Approval respectively and as well as the ratings of the corresponding examples of surface realisations.

6.3.4.1 Tell the student the answer sought

At its most extreme, this strategy is the least student-friendly one of all strategies available to teachers, as it is unceremonious and apparently disrespectful to student's needs in terms of both his Autonomy and Approval. On its better side, the strategy tends towards a more considerate, approving effect, even though it may be still limiting the amount of Autonomy that it gives to the student. Therefore, the strategy splits into two sub-strategies: *1.1 Give complete answer* and *1.2 Complete student's answer* which

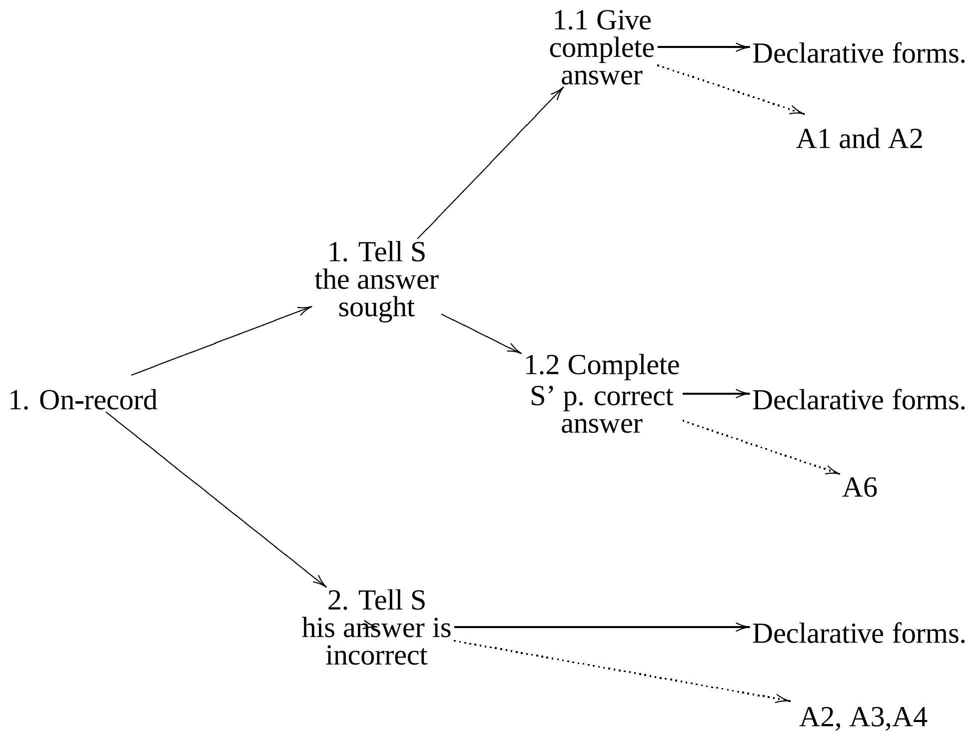


Figure 6.6: On-record strategies

Table 6.15: On-record strategies ordered from lowest to highest values of Approval and example surface forms

Lowest Approval

Strategy ID	**Strategy name**	**Rating**	**Example SF**	**SF Rating**
1.1.1	Give complete answer	0	*The answer is ...*	0
1.1.2	Complete S' answer	0	*10 or less* *No, 10 or less* *Yes, 10 or less* See the context of the utterance in subsection 6.3.4.1.2	0.1 0.2 0.4
1.1.3	Tell S his answer is incorrect	0.1	*No* *No, that's incorrect* *That's incorrect*	0.2 0.2 0.25

Highest Approval

differ primarily in terms of the amount of Approval that they express.

6.3.4.1.1 Give complete answer The Approval and Autonomy needed or wanted by a student are not only not given, but are taken away from him by this sub-strategy: Approval is neither expressed explicitly nor implicitly, which is emphasised further by the fact that student is not given any initiative and the answer is simply provided by the teacher. Both Autonomy and Approval rate 0.

However despite its bad looks, the strategy has a relatively wide application and is conditioned by specific circumstances which may justify it in the eyes of the student. The two key situational factors in this model are student's persistently slow progress (i.e., the student may have been given many chances to provide the answer sought: he would have been given a certain amount of initiative), and the lack of time combined with importance of topic (there is simply no more time left to allow the student the initiative and the topic is important enough for the teacher to give the answer away).

It is important to bear in mind that in the dialogues studied, this strategy rarely occurs without the help of one of the relevant auxiliary strategies which are used to soften its baldness, in which case the values for Autonomy and Approval are boosted by the values of the relevant auxiliary strategies (see figure 6.6). The typical surface realisations of this strategy are declarative forms.

6.3.4.1.2 Complete student's answer This sub-strategy is relatively student-friendly as it typically provides more overt Approval than that which gives the entire answer away to the student. This is mainly to do with the fact that this strategy can only (reasonably) occur in situations in which a student committed only partially incorrect action. This puts the student in a potentially stronger position of confidence in terms of his progress. While this strategy readily combines with auxiliary strategies which express overt Approval (see figure 6.6), and while in itself it is a more approving and more Autonomy giving strategy, it may still be used to cause relatively strong Face effects. The exact effect will depend on the type of speech act that the teacher attempts to commit. If the act is to disconfirm the correctness of the student's action (e.g., 6.4(a)), then the ratings for both Autonomy and Approval are very low (0 for Autonomy and 0.1 for Approval). If the act is simply to assert the remaining part of the answer, or correct the student's partially correct answer, (e.g., 6.4(b)), then while Autonomy is still at 0, the value of Approval rises to 0.2, since there is no explicit rejection of the erroneous part of the student's answer. Finally if the act used is a confirmation of the correct part of the student's answer (e.g., 6.4(c)), then while Autonomy remains 0, Approval shoots up to 0.4. All of the observed surface realisations for this strategy are declarative forms. Note, that while the lexical item *no* could be treated as part of the strategy *1.2 Tell S his answer is incorrect*, the current interpretation is that in this case it is simply a negative polarity item, of which the function is to set focus on the particular aspect of the message, namely that the student was in some way incorrect. The lexical item *yes* is a positive polarity item which focuses the attention on the positive aspect of the student's answer.

Context for the examples in 6.4:

Teacher: What is the range of voltage values you can expect?

Student: They will be under 10 volts.

(Correct Answer: They're will be 10 volts or less).

(6.4)

(a) Teacher: No, 10 or less

(b) Teacher: 10 or less

(c) Teacher: Yes, 10 or less

6.3.4.2 Tell the student his answer is incorrect

The second most extreme sub-strategy in the bald group is also realised by a declarative surface form. Generally, the degree of baldness that characterises this strategy is lesser than that of the strategy which gives the entire answer away, in that it leaves room for the student's initiative. For a teacher to state that the student's answer is incorrect is treated in this model as a way of inviting either a counter-response from him if he wishes to defend his previous answer, or as is more commonly the case, to invite further action from him. In either case, with the value of 1 the strategy rates extremely high on the Autonomy scale. The Approval ratings, on the other hand, are more varied with the top value of 0.4 and the bottom value of 0.2. Whether the Approval value is high or low depends primarily on whether or not there are negative polarity lexical forms used such as the direct negation word *no*, e.g. *No, that's incorrect* (Approval = 0.2), whether there are any hedges used such as *still, perhaps, well*, e.g. *That's still incorrect* (Approval = 0.4), or whether the expression is plain without any modifying qualities e.g. *That's incorrect* which is also treated here as a prototypical form (Approval = 0.25). The most important situational factor conditioning the use of this strategy is the correctness of student's answer, which must be in the state: *incorrect*. Other conditioning factors include the student's confidence (the student must be confident enough to be able to withstand the little Approval that this strategy may provide) and the student's aptitude (the student needs to be relatively fast to be given the maximum of Autonomy).

6.3.5 Off-record strategy

The off-record strategy is most typically used to perform FTAs in the least overt manner. In this sense, and in all relevant respects, this strategy stands at the opposite end of the baldness spectrum from the on-record strategy. Its main purpose is to hide any possible threat to a hearer's Face only by implying the real message of an action. By the same token, at its most extreme, the strategy offers to the speaker the flexibility of being able to opt out from having had any threatening intentions, while to the hearer, it offers a relative freedom in interpreting the intentions behind the speaker's action in a manner which is convenient to him (e.g., the student may interpret the question *Why?* as either a prompt for him to carry on with his current line of reasoning, or it may be understood in accordance with the teacher's intentions as expressing her doubt about the validity of the student's current reasoning or action). It is because of this flexibility that the off-record strategy is the most complex of all the strategies considered for this model with respect to the face-oriented goals that it represents. The primary source of this complexity is the fact that on the educational level the strategy is often geared to promote the student's initiative in a guided way (*Socratic Dialogue*), a concept which is by definition a slight contradiction in terms. Thus the complexity of this strategy is due to the constant tension between the need to guide the student and the need to allow him to make independent learning choices.

As shown in figure 6.7, the off-record strategy offers a richness of possibilities for addressing a student's Face. This richness is expressed by a variety of surface realisations. Because there is no systematic way of ordering the strategies simultaneously in terms of a progression of degrees of Autonomy and Approval (for example, it is not always the case that if Autonomy is low, then the Approval is also low), the strategies in the figure are ordered approximately according to how approving they are: in general, the lower the number the less approving the strategy. The degree of Autonomy is reflected in the type of structure that a strategy imposes on the student's reasoning

Table 6.16: Off-record strategies ordered from lowest to highest values of Autonomy and example surface forms

Lowest Autonomy

Strategy ID	**Strategy name**	**Rating**	**Example SF**	**SF Rating**
2.2.1.2	Question validity of S' answer in the face of facts	0.1	*Isn't the wire already in the circuit?*	0.1
2.1.1	Give 2 alternatives	0.2	*How would the current flow?* *Through the wire?* *Or throughout the meter?* *Through both?* *Or through neither?*	0.2
2.3.4	Review givens and state inferrables	0.25	*You already said that voltage is power divided by current.* *But you don't know what the current is.* *However you can make up a formula from what you know.*	0.25
2.3.1	Disconfi rm correctness of S' givens	0.3	*I=E/44 and P/I does not equal I.*	0.3
2.3.3	Use direct hinting	0.3	*That's one way, but there is another way to do this.*	0.3
2.3.2	Use RAA method	0.3–0.4	*If E=IR, how can I=ER?* *If you put the light bulb in the oven then it will get a lot of heat, but will it light up?*	0.4 0.3
2.1.2	Give more than 2 alternatives	0.3-0.4	*How would the current flow?* *Through the wire?* *Or throughout the meter?* *Or through neither?* *How would the current flow?* *Through the wire?* *Or throughout the meter?* *Through both?* *Or through neither?*	0.3 0.4
2.2.1.1	Question S' certainty regarding his answer	0.8	*Are you sure about that?*	0.8
2.2.2	Request self-explanation	0.8–1	*What gives you the idea that X?* *Tell me how you did it?* *Why?*	0.8 0.9 1

Highest Autonomy

Table 6.17: Off-record strategies ordered from lowest to highest values of Approval and example surface forms

Lowest Approval

Strategy ID	**Strategy name**	**Rating**	**Example SF**	**SF Rating**
2.1.1	Give 2 alternatives	0.2	*How would the current flow?* *Through the wire?* *Or throughout the meter?*	0.2
2.2.1.2	Question validity of S' answer in the face of facts	0.2	*Isn't the wire already in the circuit?*	0.2
2.2.2	Request self-explanation	0.2–0.3	*Why?* *Tell me how you did it?* *What gives you the idea that X?*	0.2 0.2 0.3
2.1.2	Give more than 2 alternatives	0.3	*How would the current flow?* *Through the wire?* *Or throughout the meter?* *Through both?* *Or through neither?*	0.3
2.3.1	Disconfirm correctness of S' givens	0.4	*I=E/44 and P/I does not equal I.*	0.4
2.2.1.1	Question S' certainty regarding his answer	0.4	*Are you sure about that?*	0.4
2.3.2	Use RAA method	0.6	*If E-IR, how can I-ER?*	0.3
2.3.4	Review givens and state inferrables	0.7	*You already said that voltage is* *power divided by current.* *But you don't know what the current is.* *However you can make up a formula from* *what you know.*	0.7
2.3.3	Use direct hinting	0.9	*That's one way, but there is* *another way to do this.*	0.9

Highest Approval

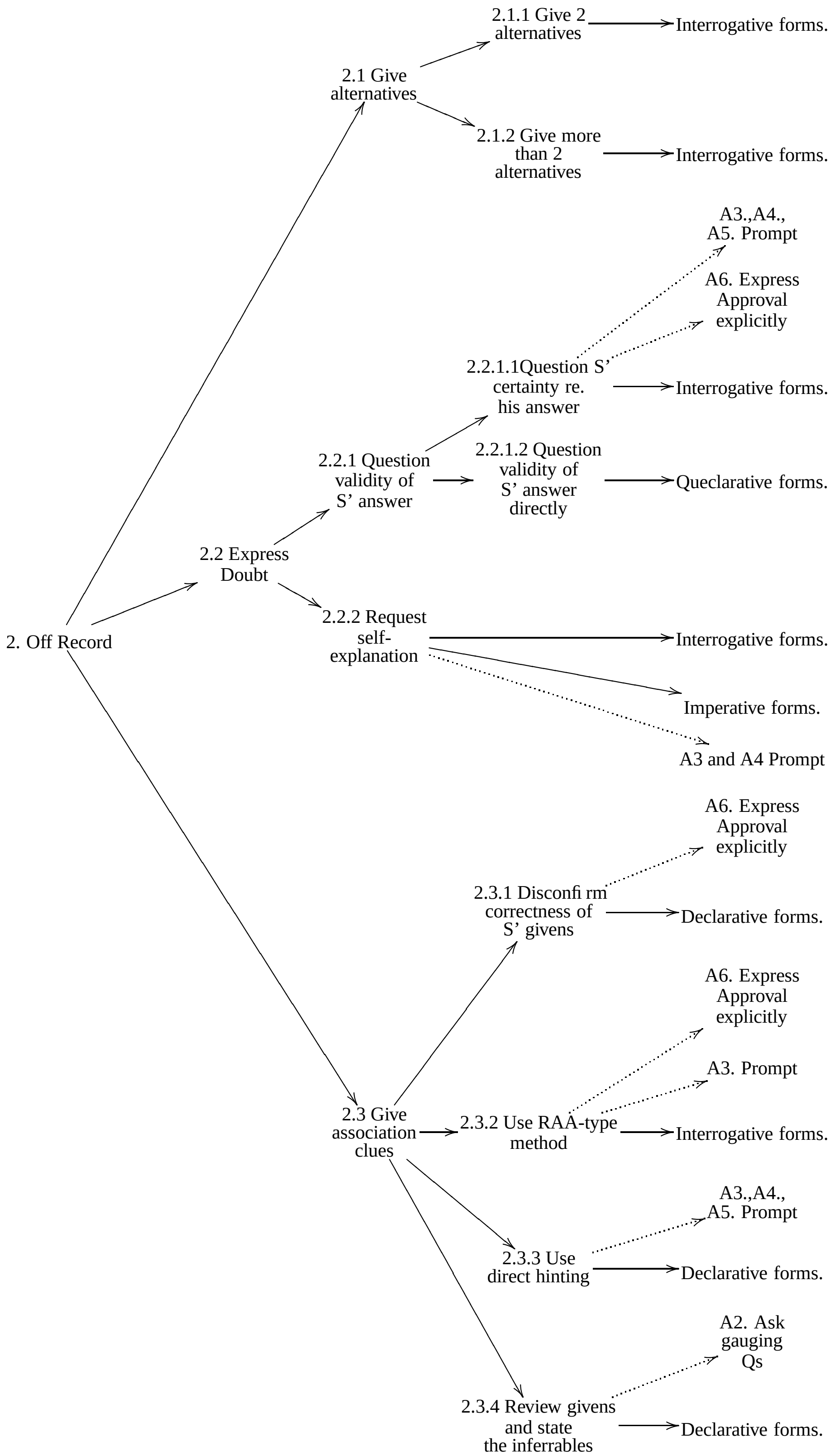


Figure 6.7: Off-record Strategy

and actions as well as on the amount of information regarding the answer sought that it implies. Each sub-strategy represents a different type of structure that can be imposed on the student's reasoning. Thus the reasoning may be structured in a way which allows the student to compare alternatives, but it may be also more elaborate and take the form of a *Reductio ad Absurdum* type of argument (see 6.3.5.3.2 for further details). Every type of structure is necessarily reflecting on the amount of Autonomy given to a student. On the one hand, in general, the more guidance that is imposed (either in the form of structure or explicit information giving), the less Autonomy the student is given, because such imposition deprives him of the initiative to decide how (or even whether) he wants to arrive at an answer. On the other hand, the strategy brings to light a curious relationship between Autonomy and Approval, which suggests that part of the Approval value may depend on the amount of effort required to impose different types of guidance on student's actions: the more structure is imposed the more effort is required to do it, and the more effort is put into doing an FTA, the more an act may be interpreted as expressing Approval. In turn, this claim is based on the Principle of Parsimony (e.g., Carletta (1992)), which states that speakers make as little effort as possible when communicating with others. If a person disapproves or does not care particularly about communicating with the other person, then the expected effort should be normal (i.e. the least possible) or less. More effort implies more commitment to the hearer, which in the case of the situations examined here is interpreted as a manifestation of greater than average Approval.

6.3.5.1 Strategy 2.1: Give alternatives sub-strategy

In most cases, if a teacher gives alternative answers for the student to choose from, she is effectively telling him the answer sought. This is the case with acts which give only two alternatives, one of which is often the student's erroneous answer. Another way of giving alternatives is for a teacher to increase their number, thereby focusing the student's attention on the relevant issues without actually giving the answer away.

6.3.5.1.1 Sub-strategy 2.1.2: Give 2 alternatives Within the off-record strategy, this sub-strategy may lead to relatively least informationally ambiguous, and the most bald actions. It affects the student's Autonomy and is typically used in situations in which the student has committed an incorrect action, is relatively confident and may be persistently slow. As a consequence, and despite the fact that the strategy keeps up the pretence of actually giving the student some initiative, the Autonomy value is quite low (0.2). The strategy also rates relatively low in terms of Approval. In this respect, the only difference between it and the on-record strategy which leads to the student being told the answer sought is the fact that this strategy is expressed by interrogative surface forms, which in Face threatening situations tend to act as natural hedging devices. Thus the Approval value for this strategy also falls in the region of 0.2.

6.3.5.1.2 Sub-strategy 2.1.2: Give more than 2 alternatives To give more than two alternatives means to be less informationally explicit than suggesting only two choices to the student. The more alternatives the teacher gives to her student, the less she can be claimed to give the answer away to him. The Autonomy value for this sub-strategy depends on the actual number of alternatives given. Based on the dialogue analysis, teachers seldom produce acts which consist of more than four alternatives. Given that the Autonomy value for two alternatives is 0.2, the value for three alternatives increases to 0.3, while for four alternatives – to 0.4. On the other hand, by virtue of more effort being required from the teacher in giving more choices to the student, the value for Approval increases only slightly (to 0.3) in comparison to that assigned to two alternatives. A typical situation in which this strategy could be used involves a student who is incorrect, who is relatively confident and interested and where the overall time constraints (time left relative to amount of material left) are sufficiently low to allow for certain amount of initiative on the student's part, but which are not low enough for a complete Autonomy.

6.3.5.2 Strategy 2.2: Express Doubt

Judging on the basis of the dialogue analysis presented in Chapter 3, this strategy is one of the most frequently chosen by teachers, probably because it fits best the Socratic dialogue teaching methodology. Its aim is to focus a student's attention on the validity of the relevant aspects of his problem solving, his actions or claims. There are several ways in which this strategy may be realised and the values for Autonomy and Approval depend on the actual realisation chosen. At one extreme this sub-strategy leads to acts which are the most ambiguous in terms of the messages that they convey. They give a teacher a way of opting out from any possible implications that such an FTA may carry. At another extreme, the strategy is relatively bald and unambiguous. Ultimately the choices of strategies are determined by the situational constraints imposed on the teacher by a current situation.

6.3.5.2.1 Sub-strategy 2.2.1: Question a fact/a state of affairs One way for a teacher to express her doubt regarding the validity of the student's action or claim is to question it directly. There are two most common strategies which are used to achieve this effect. They differ quite visibly with respect to both Autonomy and Approval that they express.

6.3.5.2.1.1 Sub-strategy 2.2.1.1: Question S' certainty regarding his answer When a teacher questions the student's certainty regarding his action, she leaves relatively plenty of scope for the student to take the initiative to explain his reasoning. In this respect the Autonomy value is very high: 0.8, which makes this strategy similar to the on-record strategy of telling the student that his answer was incorrect. However this strategy rates lower on the Autonomy scale than the *1.2 Tell S his answer is incorrect* on-record strategy, mainly because a questioning act explicitly invites self-explanation on student's part, thus pre-emptying his initiative slightly. The questioning nature of this strategy also leads to a much higher degree of Approval than that of the on-record strategy as it falls around 0.4. The key situational factor is that of the students low confidence coupled with the student being incorrect and lack of temporal urgency in the form of either plenty of time being still available or there being relatively little left to teach.

6.3.5.2.1.2 Sub-strategy 2.2.1.2: Question validity of S' answer in the face of facts The optimal use of this strategy depends on the student's high confidence coupled with a persistently slow progress, possible lack of student's interest, an incorrect action and relatively little time left till the end of the lesson. This sub-strategy contrasts sharply with its sister sub-strategy (2.2.1.1) both in terms of Approval and Autonomy values which are very low (0.2 and 0.1 respectively). The Approval value is low, because there no explicit or implicit Approval given, except for the softening tone of the questioning act, hence the value is higher than that of an on-record statement, for instance, in which the student is told that his answer was incorrect. On the other hand, the Autonomy value is low because there is practically no scope for the student's initiative: the strategy is typically realised by queclarative forms which by definition are not information seeking questions; rather they are acknowledgement/agreement seeking acts (see the dialogue analysis in Chapter 3 for an explanation of queclarative forms), and thus an indirect way of performing assertions.

6.3.5.2.2 Sub-strategy 2.2.2: Request Self-Explanation In general, the key reason for a teacher to use this strategy is her lack of certainty regarding the exact nature of the student's misconception. Effectively, such lack of certainty means that the teacher cannot impose a reasoning structure on the student in an informed way. In such situations, a request for self-explanation is often preferred to other types of strategies. There are two ways in which the teacher may request self-explanation, and the choice depends primarily on whether the previous action/answer is completely incorrect or only partially correct. Thus, if the student's action is completely incorrect, it is more likely that the teacher will ask the student a self-diagnosis question, which is typically realised by an interrogative form such as *What makes you think that X?*. On the other hand if the student's answer is only partially correct, it is likely that the teacher will be more direct simply because she needs to focus the student's attention on the incorrect part of his response. The more direct form of this strategy is also realised by interrogatives such as *How did you solve this*, but it can be also expressed by means of an imperative form such as: *Tell me how you did it.*

Apart from allowing for different types of surface form, this strategy gives a lot of scope for varying the interrogative forms depending on the amount of structure that the teacher wants to impose on the student's reasoning towards an answer. In turn the amount of structure imposed is determined by the specific situational factors being in particular states. If the student's progress is persistently slow, his confidence is high and there are time and amount of material restrictions, the teacher is likely to ask a focusing/highly informationally structured question such as *What gives you the idea that the rheostat tells you what the current is?*. On the other hand, if the student's progress is relatively fast and/or, crucially, if there is relatively plenty of time left, the teacher is more likely to ask an open question such as *Why?*. In either case the teacher allows the student a high degree of Autonomy (0.8 for the first, 1 for the latter example), as the self-diagnostic questions allow the student to take the initiative of self-explanation and self-diagnosis in his own hands. In contrast to Autonomy, the Approval value for this strategy is quite low (0.2 - 0.3), due to the lack of explicit Approval as well as due to explicit threat to student's positive self-image by virtue of forcing him to identify and to admit his mistakes. In this respect the strategy leaves little scope for student self-defence and counter-reply. For the imperative forms such as *Tell me how you did it* the Autonomy value is 0.9, while the Approval is 0.3. Both values are higher than those of the first interrogative because, despite the directive character of the utterance, it neither suggests the answer nor specifically suggests the teacher's assessment of it, which could coerce the student into giving a particular response.

6.3.5.3 Sub-strategy 2.3: Give association clues

This strategy leads to the most structured actions, thus guaranteeing relatively little Autonomy. It is also a strategy that requires a considerable effort both in terms of its physical, surface realisations and in terms of the intellectual effort required by the teacher to lead the student's reasoning in an appropriate way. In this sense the Approval values for the corresponding sub-strategies are higher than the values of either the *Give* *alternatives* or *Request self-explanation* strategies. The reasoning structure imposed by an application of this strategy may take different forms depending on the actual error and the degree of error (partially correct or completely incorrect) that the student made in his previous action. There are four main sub-strategies which reflect the variations in form. The complexity of this strategy is also reflected in the variations in the actual values of Autonomy and Approval.

6.3.5.3.1 Sub-strategy 2.3.1: Disconfirm correctness of S' givens This sub-strategy is typically used in situations in which the student's action is incorrect by virtue of his assumptions for committing the action being incorrect. The optimal use of this strategy also requires the student to be relatively confident or for there to be a considerable time pressure. The Autonomy value for this strategy is relatively low (0.3), because the teacher is not leaving any scope for student's initiative to find out about the incorrectness of his assumptions independently. The strategy also rates relatively low on the Approval scale (0.4), both because there is no overt Approval found in the strategy, and because not much effort is required to apply it. The typical surface realisations involve declarative forms, such as *I=E/44 and P/I does not equal I*.

6.3.5.3.2 Sub-strategy 2.3.2: Use RAA-type method This sub-strategy is very commonly used by teachers as it is both leading the student's reasoning and actions and it is, on the whole, relatively highly approving of the student (Approval value for this strategy falls between 0.3–0.6 depending on the presence and the number of hedges). The application of this strategy often requires a considerable effort both physical, but especially intellectual on the part of the teacher. The strategy typically takes a form which resembles (but is not necessarily a faithful rendition of) the *Reductio ad Absurdum* method used in propositional logic to arrive at the truth of a proposition through contradiction. The main gist of this strategy is to frame the student's incorrect or partially correct action in a possible scenario in which it will stand out as incorrect or even absurd and which thereby will make the student realise his mistake. The strategy leads to highly structured actions, which although they do not tend to give the answer away to the student, they lead him explicitly to it. The leading nature of the

RAA strategy impacts strongly on its overall Autonomy value which falls in the region of 0.3 - 0.4 (depending on whether it is an obvious flaw in the student's reasoning or whether the student needs to do some inference before). The typical surface realisations are interrogatives with *if-then* frames, e.g. *If E=IR, how can I=ER?*. Because the strategy can be used to address both incorrect and partially correct student actions, other situational factors need to be used to determine it optimal use. The student's low confidence together with relatively plenty of time left tend to be the key factors for this strategy.

6.3.5.3.3 Sub-strategy 2.3.3: Use direct hinting Sometimes teachers prefer to tell the students directly not only that there are other ways of solving a problem, but also they want to point those ways to them. In such situations they will resort to using direct hints, e.g. *Think about the relationship you know about*. The strategy leads to actions which although highly informative, do not give the answer away. They do however take the student "by his hand" and lead him explicitly to the answer. Because of this the Autonomy value is the same as that of the RAA method – 0.3, as the student is not (or cannot be) given the freedom of initiative to choose the desired path of reasoning. In terms of the Approval value the strategy rates slightly higher than the RAA strategy (0.9) because there is an explicit reference to the student possessing the correct knowledge to solve a problem in a desirable way. Note that such reference making is not true of all hinting, and thus this strategy should be treated as a sub-category of hinting in general. The key situational factors are time left, which needs to be in the state: *plenty*, student's relatively high confidence and interest, the student's progress must be relatively fast and the material must be important enough for the teacher to give such strong association clues. The typical surface forms used to express this strategy are declarative forms.

6.3.5.3.4 Sub-strategy 2.3.4: Review givens and state the inferrables This strategy relies on plenty of time being available to the teacher, the material being important enough to spend a considerable time on covering it, a student whose confidence is relatively low and possibly bored, and on an incorrect answer. Because this strategy leads to actions which give a lot of information away to the student, its rating in terms of Autonomy is rather low (0.25). On the other hand, this strategy rates quite high on the Approval scale (0.7), because just as giving hints directly, it makes explicit reference to the correct parts of the knowledge that the student already possesses. It also requires a lot of effort to produce. The typical surface realisations for this strategy are multiple declarative forms, such as *You already know that voltage is power divided by current. But you don't know what the current is. However you can make up a formula...,* etc.

6.3.6 Choosing a strategy and Autonomy and Approval values for a surface form

This section provides two examples of the process by which the linguistic component of the current model allows one to decide the type of the strategy and to assign the values of Autonomy and Approval to specific surface forms. This is the process which is needed every time a new surface form is added to the set of Surface Forms. There are two steps in this process. First, the surface form needs to be categorised in terms of a particular strategy or a set of strategies in the strategic system. Second, a surface form needs to be given specific Autonomy and Approval values which will fall within the numerical range associated with the strategy or if there are multiple strategies, the numbers are derived from all the numbers associated with contributing strategies. If the range is a single value then the choice is simple. If the range is really a range, i.e. there are several possible values that could be assigned, then the form needs to be assessed further with respect to other forms corresponding to the given strategy and with respect to the guidelines for assigning the particular values according to specific surface features.

The first example shows this process in the context of a simple main strategy, while the second example is concerned solely with demonstrating the way in which the Autonomy and Approval values are calculated for a surface form which is the product of a complex strategy based on the weighted mean function introduced in section 6.3.2.

6.3.6.1 Example 1: Choosing a strategy and $\langle Aut, App \rangle$ values

A simple strategy can be any one of the main strategies (either on-record or off-record) described in the previous sections. One such strategy is strategy *2.2.1.2 Question the validity of a student's answer directly* and an example of it would be a queclarative form such as *Isn't the wire already in the circuit?*.

When trying to guess the strategy of which the given queclarative form is an instance, it is necessary to follow the guidelines presented in the form of questions in table 6.18. By the same token, the figure shows the way in which one would arrive at the value of Autonomy for this particular form. Table 6.19 shows the same process with respect to Approval.

Each table lists a set of questions which are useful in establishing the strategic identity of a surface form. All of the questions asked are responsible for the final conclusions in the sense that one question determines the nature of the next question. The set of all possible questions can be viewed as similar to a discrimination network which specifies which questions follow from what previous ones, eventually leading to the final strategies and Autonomy and Approval values. The initial questions are asked for all surface forms. The following questions and the corresponding conclusions are determined by whether the answer the initial questions is a "YES" or a "NO".

The guidelines (in the form of the questions such as shown in the two tables) for determining a strategic identity of a surface forms are needed in addition to the strategic system. The strategic system tells one about the hierarchy of different strategies employed by teachers in situations in which they have to correct a student and it gives examples of surface forms which can be classified in terms of those strategies. However, faced with a brand new surface form one needs to be able to determine its strategic class. One cannot do this easily and reliably by means of just rampaging through the strategic system as a surface form may not obviously and immediately fit any of the strategies. The guidelines provide one with a way of finding the most likely strategy in a systematic way which can be applied to all of the surface forms encountered in the educational circumstances currently under investigation. The strategic system and the

Table 6.18: Choosing a Strategy of and assignment of Autonomy value to the surface form *Isn't the wire already in the circuit?*

Q1: Which Strategy produced *I*sn't the wire already in the circuit?
Q2: What is the Autonomy value for that form?

Question	**Answer**
1. Is the answer sought by the teacher given explicitly to the student?	NO
2. Is the answer sought by the teacher given implicitly (suggested) to the student	YES
3. Is the answer suggested by means of alternatives?	NO
4. Is the answer suggested by means of expressing doubt?	YES
5. Is the doubt expressed by student's certainty regarding his previous action being questioned?	NO
6. Is the doubt expressed by the validity of student's answer being questioned?	YES

Conclusion re Q1:
The strategy is *2.2.1.2 Question validity of student's answer directly*

Conclusion re Q2:
Autonomy = 0.1

Table 6.19: Choosing a Strategy of and assignment of Approval value to the surface form *Isn't the wire already in the circuit?*

Q1: Which Strategy produced *I*sn't the wire already in the circuit?
Q2: What is the Approval value for that form?

Question	**Answer**
1. Does the surface form contain an explicit, positive reference to the student's prior/current progress or to his positive traits?	NO
2. Is approval given implicitly either by means of the relevant auxiliary strategies or by means of association clues being given?	NO
3. Is there reference to the student's positive traits and/or his achievements?	NO (no, there isn't)
4. Is the complete answer given away to the student?	NO
5. Is part of the answer given away to the student?	NO
6. Is the student's answer criticised for its incorrectness?	NO
7. Is there a strong implication of the incorrectness of the student's answer?	YES
8. Is the implication made by means of presenting the student with alternatives?	NO
9. Is the implication made by means of expressing doubt?	YES

10. Is the doubt expressed by the validity of the student's answer being questioned? YES

11. Is the the validity of the student's answer questioned by means of the student's certainty regarding the correctness of that answer being questioned? NO

12. Is the the validity of the student's answer questioned directly? YES

Conclusion re Q1:
The strategy is:*2.2.1.2 Question validity of student's answer directly*

Conclusion re Q1:
Approval = 0.2

guidelines are consistent with one another as they have been developed in parallel – often one informing the design of the other.

6.3.6.2 Example 2: weighted mean function for assigning Autonomy and Approval values to compound forms

A complex strategy includes one or more main strategies and one or more auxiliary strategies. The surface form 6.5 is a result of one such a combination. Using the same process of categorising surface forms as instances of particular strategies, it was established that the surface form in 6.5 contains one main strategy, namely the strategy *2.3.2 Use RAA-type of strategy*, and one auxiliary strategy, namely *A3.3 Imply togetherness*. The Autonomy and Approval values for each of the forms is established based on the numerical ranges associated with each strategy and based on the further guidelines specified in the sections 6.3.3.3.3 and 6.3.5.3.2 for auxiliary strategy and for the main strategy respectively. Thus, the values of Autonomy and Approval for the main and for the auxiliary strategy are (0.3, 0.7) and (0.4, 0.7) respectively.

When calculating the values of Autonomy and Approval for a complex strategy the Autonomy and Approval values of the individual strategies involved need to be combined in such a way as to reflect their contribution to the overall communicative and face-oriented effects. The weighted mean function (repeated in equation 6.6 for ease of reference) used to calculate the overall Autonomy and Approval values for a compound strategy has been explained in section 6.3.2. Below is an example of the way in which it is used to calculate the needed values for the form in 6.5.

(6.5) Let us try again. Say, the black lead is connected to tab 4. Which tab positions would be included in the positive side of the circuit?

$$autonomy|approval = \frac{\sum_{i=1}^{n}(main_i * mainW_i) + \sum_{i=1}^{m}(aux_i * auxW_i)}{\sum_{i=1}^{n} mainW_i + \sum_{i=1}^{m} auxW_i} \tag{6.6}$$

Where for aut: $\mathrm{mainW}_i = 1$, $\mathrm{auxW}_i = 0.5$, and for app: $\mathrm{mainW}_i = 1$ and $\mathrm{auxW}_i = 1$

$$aut = \frac{(0.3 * 1 + 0.4 * 0.5)}{1.5} = 0.33333 \tag{6.7}$$

Where 0.3 is the Autonomy value of the main strategy and 0.4 is the Autonomy value of the auxiliary strategy.

$$app = \frac{(0.7 * 1 + 0.7 * 1)}{2} = 0.7 \tag{6.8}$$

Where 0.7 is the Autonomy value of both the main strategy and the auxiliary strategy.

The resulting overall values of Autonomy and Approval for the surface form in 6.5 are 0.33333 and 0.7 respectively. Both values seem plausible. While the Autonomy value of the main strategy was increased by the addition of the Autonomy values of the auxiliary strategy, the increase was only slight reflecting the fact that both strategies imply a considerable amount of guidance being given to the student. On the other hand both strategies lead to highly approving acts which is reflected in the combined value of 0.7.

6.4 Summary

In this chapter the entire model of teachers selecting responses to students' erroneous actions was presented. The model divides into two main components: the situational and the linguistic component. A grouping of the situational factors was proposed which grouping was motivated by the results of the study presented in Chapter 5. A method for inferring the Autonomy and Approval values from the various combinations of factors was proposed. The Autonomy and Approval values are used in the model to link the situational component and the linguistic component. The linguistic component consists in a classification of strategies which teachers tend to use in different situations in which they need to address a students incorrect or partially correct action. Although not explicitly used in the model to reason about the linguistic possibilities available to teachers in such situations, the strategies are a useful way of analysing such possibilities. A method for assigning the Autonomy and Approval values to different strategies was proposed. A set of guidelines was established for the purpose of guiding the assignment of Autonomy and Approval values to individual surface forms and a method for inferring the two values for surface forms which combine different strategies was given.

In the following chapter the implementation of the model into a system for making linguistic recommendations for specific situations is presented.

Chapter 7

The Implementation of the Model

7.1 Introduction

This chapter presents the implementation of the model in terms of a system for inferring appropriate surface forms given an input situation description. The primary purpose of the implementation is to provide a computational workbench for evaluating the model. It is also to affirm that such a model is formally and computationally possible.

On a general level, the architecture of the system mirrors the structure of the model presented in Chapter 6. The system is implemented using two well known AI techniques. Each technique is used for the implementation of one of the two main components of the model: the Situational Component which is implemented primarily using Bayesian Networks, and the Linguistic Component which is represented and exploited by means of Case Based Reasoning (CBR). Additionally, CBR is used to pre-process the input to the Bayesian Network. A K-nearest neighbour algorithm (KNN) is used in this implementation to select the appropriate cases from the two case bases used in the system. Figure 7.1 illustrates the overall structure of the system.

The whole system is implemented in the C++ programming language, except for the user interface which is implemented in Visual Basic. For the Bayesian Network the SMILE[1] library was used which for certain platforms, such as Microsoft Windows and Linux, comes with a graphical user interface (GUI). The GUI (called GENIE) allows one to create the structure of Bayesian Networks without having to code them explicitly in C++ which, in the case of the network presented in this chapter, would have been very cumbersome. Once the structure of the network is in place, SMILE functions can be used to create code which reads the network, writes the prior and conditional probabilities into the individual nodes, sets evidence on the nodes and to runs the network.

No specific software package was used to implement the Linguistic Component, which was coded entirely by the author of this thesis. However, the structure of this part of the system reflects the basic ideas and search techniques used within Case Based Reasoning, and was inspired by the CBR Tool developed at the AIAI, Edinburgh University (AIAI, 2003).

The current chapter is organised as follows. Section 7.2 presents the overall structure of the system, shown in figure 7.1, and discusses the function of each of the components on a general level. In the further sections, the discussion is taken onto a specific level with three main reasons for using Bayesian Networks being given, a detailed outline of the design and of the use of Bayesian Network in section 7.3, and the outline of the implementation of the Linguistic Component in 7.4. Section 7.5 provides a detailed example of the system when in use, while section 7.6 provides the summary of the chapter.

7.2 The Overall System

The system consists in two main components: the Bayesian Network (BN) which is used to represent the situational part of the model, and a Case Base (CB2) which is used to store the surface forms encoded for Autonomy and Approval values using the guidelines provided by the strategic system part of the model. Additionally the

[1] Both SMILE and GENIE are decision-theoretic software and have been developed by the Decision Systems Laboratory, at the University of Pittsburgh (DSL, 1999).

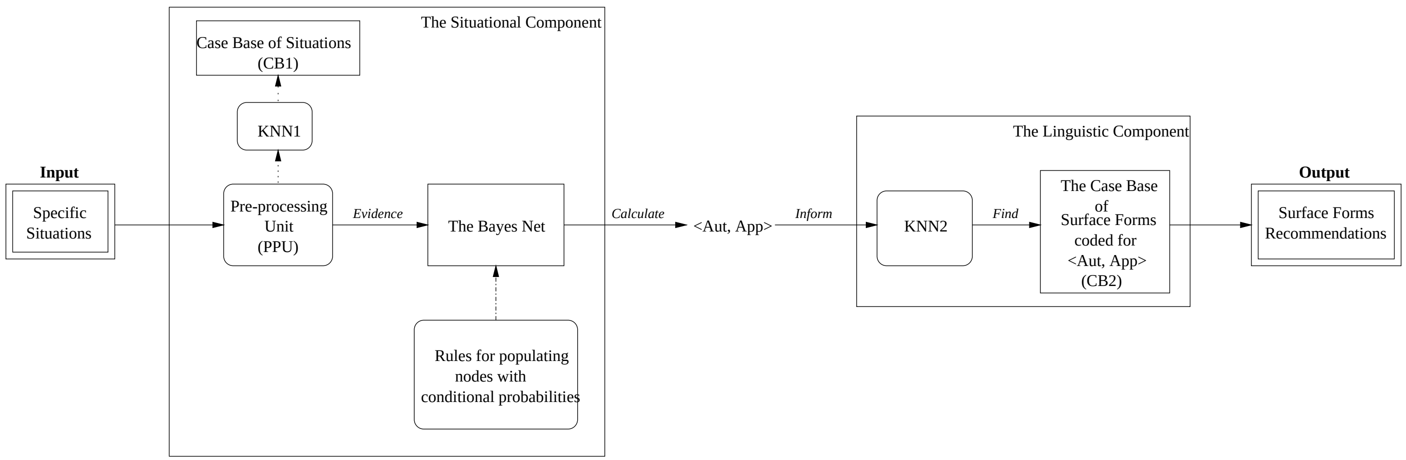


Figure 7.1: The Overall System

situational part of the system uses a Case Base (CB1) which stores all the situations for which the individual factor-value pairs were ranked for importance by the teachers participating in the study. For each factor-value in a specific situation, the results of the study were used to calculate its mean importance value. This importance value is referred to in the current model and system as its *salience* (see also Chapter 6 for an explanation of salience).

The input to the situational part of the system consists in a situation specification in the form of a combination of concrete factor-value pairs, for example TIME LEFT: *plenty*, DIFFICULTY OF MATERIAL: *difficult*, STUDENT'S CONFIDENCE: *not confident*, etc., and their respective saliences as established for a given combination on the basis of the study with teachers. A complete list of all the eight factors and their possible values was presented in Chapter 4, table 4.1. Currently the system only allows for complete situation descriptions as inputs, which limitation was imposed by the fact that the SMILE software used in the current implementation of the model's situational component was unable to handle a relatively large number of connections (64) between the original input nodes and the second level nodes originally responsible for selecting the salience values of the individual factors in the input combinations. Furthermore, the software could not deal with the resulting sizes of probability tables which had 18^8 entries each![2]. This also became the main reason for implementing a Pre-Processing Unit responsible for preparing the input to the network, thereby avoiding the software problems.

A situation specification is passed on to the Pre-processing Unit (PPU) which is responsible for turning it into *evidence* to be set on each input node in the Bayesian Network. For example, if one of the factor-values in a given situation description is DIFFICULTY OF THE MATERIAL: *difficult* with some salience S_{diff}, then the evidence set on the node *Diffi culty Salience* will be 1, i.e., true, for the state corresponding to *difficult*S_{diff} and 0, i.e., false, for all the other possible states characterising that node. Evidence is necessary for enabling the running of the BN. The pre-processing of an input situation relies on the information stored in the CB1. The CB1 consists in all of

[2]The same problems occurred when other software was tried such as VisMOD by Zapata-Rivera and Greer (2001).

the situations seen and importance-ranked by the teachers in the study (see Chapter 5 for details). For all of the situations that were seen more than once, a mean is derived for each factor-value pair in a given situation. Such a mean represents the overall importance ranking (i.e., salience) of a given factor-value in a particular situation. For all the situations that were seen only once, the ranking of their individual factor-values is used as found in the study, i.e., without any further calculations being done.

Because, as was stated in Chapter 5, only 54 out of the total of 64 tested situations were actually seen by the teachers, only the 54 situations and the appropriate salience values for each of the factor-value pairs in them are stored in CB1. As was also explained in Chapter 5, owing to a small subject pool being available to the author, the study was designed to test only 64 situations. However, since in the current model a situation consists of eight factor-value pairs, the total number of permutations for which the model needs to account is 256. This means that together with the 10 out of the 64 situations for which the study failed to account, there is a missing information for about 202 situational permutations. The system deals with this problem in the following way. When a situation specification is provided to the system, the PPU searches for an identical situation in the CB1. If such a situation is found, the evidence can be set on the appropriate nodes in the Bayesian Network. If there is no such situation available, the pre-processor searches the CB1 for the closest three matches. For each of the factor-value pairs in the input situation, a mean salience is calculated based on the individual salience of each corresponding factor-value, in each of the closest matches.

Once all the pre-processing is done, evidence, which constitutes the input to the network, can be set on the appropriate nodes in the network. After the pre-processing stage, the evidence consists of a situation specification, i.e. the list of all the factor-values, and the salience values that have been either found or calculated by the pre-processing unit. This evidence is then propagated through the network which, based on the conditional probabilities, calculates the two values of Autonomy and Approval. While the $\langle \mathrm{Aut}, \mathrm{App} \rangle$ values constitute the output from the Situational Component part of the system, they are also the input to the Linguistic Component part of it.

The Linguistic Component of the system consists of a simple Case Base Reasoner which, in turn, consists in a case base (CB2) and a K-nearest neighbour search mechanism (KNN1 and KNN2 respectively). CB2 stores a number of different surface forms which are manually coded for $\langle Aut, App \rangle$ using the strategic system guidelines presented in Chapter 6. Once the input to the Linguistic Component is provided in the form of the $\langle Aut, App \rangle$ values, the KNN algorithm is used to find the closest match in the CB2, based on the $\langle Aut, App \rangle$ values associated with each case. The output of the system consists in an example of a surface form that, according to the model, could be produced optimally in the situation specified as the input to the system.

The following sections provide further details of each of the system's components with a special emphasis on a detailed description of the Bayesian Network, which is by far the most complex part of the system computationally.

7.3 The implementation of the situational model

The choice of Bayesian Networks to represent the situational component of the model is strongly motivated by its primary purpose which is to represent the process of making linguistic decisions given a finite set of pre-defined constraints – in the case of the current model – a set of situational factors introduced in Chapter 4 and described in detail in Chapter 6. Specifically, Bayesian Networks are used for three reasons.

The first and primary reason for using the Bayesian Networks method, as opposed to a traditional NLG method such as planning or systemic networks is the functional complexity along with the non-discrete nature of speech acts. As has been signalled in Chapter 2 and specifically in Chapter 3, the assumption on which the model is based is that speech acts cannot be classified in a discrete manner as is suggested by the traditional speech act theories (e.g., Searle (1979)). Instead, a single linguistic act can be often characterised by a multitude of communicative functions and may belong to more than one speech act category. As was discussed in Chapter 3, an alternative way to view linguistic acts is in terms of degrees to which they belong to a particular type. In the case of the current model, such membership is determined by the degrees of content and illocutionary specificity in terms of which, in Chapter 4, the two dimensions of

Face were defined. Autonomy and Approval values of a linguistic act are treated then as referring to the degrees to which such an act can be characterised in terms of the strategic categories presented in Chapter 6, with Autonomy and Approval contributing to this characterisation in different ways. Bayesian Networks allow for the Autonomy and Approval to be calculated for a number of different situational contexts. This means that they provide a way which is theoretically consistent with the notion of non-discreteness of linguistic acts. Because the Bayesian method does not impose an interpretation on the output that is produced by its means, these probabilities can be interpreted as degrees to which the relevant interpretations of the two dimensions apply in a given situation.

The second reason for using Bayesian Networks is that they are an efficient method for making decisions based on some evidence from the real world. In that sense they provide an intuitively natural way of reproducing certain diagnostic and decision making capabilities of a human teacher. Since A Bayesian Network can be considered as a probabilistic expert system (e.g., Guo and Hsu (2003)), this ability is particularly suitable for modelling teachers' expertise in making judgements as to the optimal linguistic responses to students' erroneous actions. More importantly Bayesian Networks allow one to model complex dependencies between random variables in an efficient manner. As was demonstrated and discussed in the previous chapters, it is precisely the purpose of the current model to represent such complex dependencies between situational factors and to use them to infer the Autonomy and Approval values. In contrast with rule-based systems, for instance, in which representing such dependencies would not only be very cumbersome, but also very difficult to inspect and to change, Bayesian Networks provide a compact way of describing the entire distribution of the variables in terms of manageable and inspectable probability tables (e.g., Heckermann (1996); Guo and Hsu (2003)) – they facilitate efficient storage of data.

The third reason for using Bayesian Networks is their ability to instantiate arbitrary subsets of variables (regardless of whether or not they are fully specified or underspecified) and to calculate the conditional distributions on another subset in order to make a decision based on those distributions. In other words, just as they provide an efficient way of storing large amounts of complex data, Bayesian Networks have the capability of performing inference in an efficient manner which is ideally suited to the current problem. In the case of the current model the conditional distributions of all the relevant stages in the process of making a decision about the appropriate levels of Autonomy and Approval are based on the instantiations of the situational factors provided as the input to the model.

7.3.1 Overview of Bayesian Networks

In general, the input to a Bayesian Network consists in *evidence* that a certain event modelled by a given network has occurred. The output of the network consists in the probabilities of other events, modelled by the net, occurring given the supplied evidence.

Any given Bayesian Network consists of nodes and arcs which connect the nodes. The nodes represent either *pre-conditions* required by the next level of nodes, or *rules* for combining the pre-conditions required to perform an inference. Whether a node represents a pre-condition or a rule is expressed by means of that node's definition in terms of probabilities. The same node may represent both a pre-condition to another node, and a rule stating how its pre-conditions combine and what effects are produced (Heckermann (1996); Jensen (1996)).

Nodes that merely represent pre-conditions, i.e. those that do not have any pre-conditions themselves are defined in terms of their *marginal probabilities*. Marginal probabilities do not depend on any other nodes or on other nodes' probabilities. They reflect a general, albeit still subjective, probability of a phenomenon's occurrence regardless of anything else that may be happening in the same universe of discourse.

Nodes which represent rules, are defined in terms of their *conditional probabilities*; they reflect a dependency on other events in the same universe of discourse. In the graphical notation (shown in figure 7.2), a dependency between nodes is expressed by means of arcs which connect the nodes. Typically arcs reflect a designers intuitions as to the causal relationships between the nodes. For a network to be Bayesian, the arcs

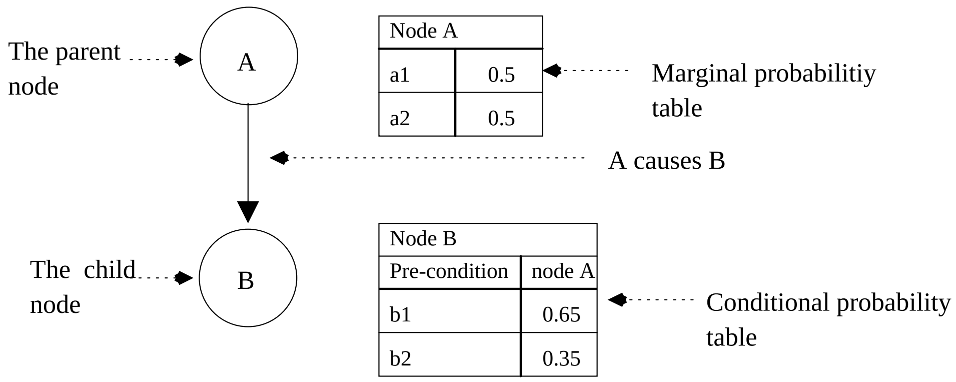


Figure 7.2: An example of a simple Bayesian Network and the dependencies between the nodes.

need to be directed. This means that the relationships between nodes can be only unidirectional, thus not circular. For example, given a node A and a node B, the possible arcs connecting them may be either an arc from A to B, or from B to A, but not both simultaneously. Such restrictions on the possible types of arcs ensure a family-tree-like topology of the network, where some nodes can be interpreted as the causes (*the parents*) of the nodes below (*the children*). This is the kind of topology which suits the problem at hand, where the nature of some phenomena (e.g., teacher's goals) is assumed to rely on the occurrence and on the nature of some other phenomena (e.g., a sufficiently specified situational context). In other words, a teacher's communicative goals do not occur unless they are triggered by a particular set of circumstances, and her linguistic decisions are the effects of acting upon those goals.

In a Bayesian Network, every node needs its marginal or conditional probabilities specified *prior* to *running* the network. The running of the network happens after the appropriate evidence is supplied. Running the network means propagating the evidence through the network by means of an appropriate probabilistic inference algorithm.

There are several inference algorithms available to the designers of Bayesian Networks. The most commonly used is the type of algorithm proposed by Lauritzen and Spiegelhalter (1988) and further developed by Jensen (1996) amongst others. In this type of algorithm a Bayesian Network is transformed into a tree in which each node corresponds to a subset of variables in the transformed network. The transformation into a tree is sometimes necessary to avoid an infinite loop in the propagation of values across the nodes. Such a problem can arise in cases where in the Bayesian Network there exists an acyclic loop between the nodes. The choice of an algorithm typically depends on the size of a given network. The Lauritzen-Spiegelhalter algorithm is suitable primarily for relatively small-sized networks (DSL, 1999). This is also the algorithm used in the current implementation. For larger networks it is best to use an algorithm which exploits stochastic sampling methods such as those proposed by Henrion (1988), Shachter and Peot (1990) or Fung and Del Favero (1994).

The prior probabilities can be either made up, or they may rely on some data which is representative of the modelled world. Whenever possible, it is considered a good practice to populate a net with prior marginal and conditional probabilities which express some general tendencies within the world which the network portrays. Such prior probabilities can be only obtained from real data. However, it is often the case that the needed data is either unavailable or it is incomplete as is the case with the current model. In such cases the prior probabilities need to be inferred by some other means such as they may have to be based on the designer's intuitions, relevant literature, etc.

Every node in a Bayesian network consists of at least two *states*. When evidence is set on a node, only one state is flipped to TRUE, while the rest of the states are flipped to FALSE. Specifically in relation to the current model, this is very suitable for representing the mutual exclusiveness of situational factor-values in the input nodes. In any given situation, the factor STUDENT'S CONFIDENCE, for example, may be either *confident* or *not confident*, but not both simultaneously. In this case, STUDENT'S CONFIDENCE represents the node, while *confident* and *not confident* represent its two possible states.

Every node carries information in the form of a probability table, which expresses the probability of a node being in one of the pre-specified states. If a node represents

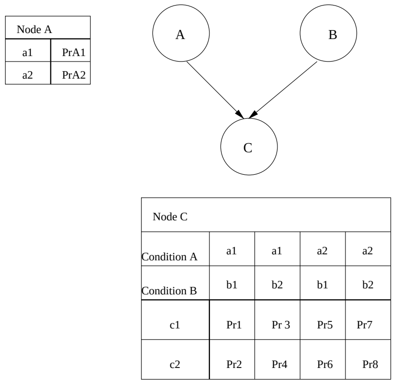


Figure 7.3: An example of a simple three-node network.

pre-conditions only, its definition will consist of a number of fully specified possible states, along with their marginal probabilities. For example, if a node A with the states *a1* and *a2*, does not have any parents, its probability table will merely express the respective probabilities of *a1* and *a2* (see figure 7.2 and figure 7.3).

If a node represents a rule, the definition will consists of a number of its possible states, all of the combinations of all the states of that node's pre-conditions (i.e. the parent nodes) and prior, conditional probabilities for every such combination. For example, if a node C with the possible states *c1* and *c2* is a child of A and B with the states *a1*, *a2*, and *b1*, *b2* respectively, then the probability table will express the respective probabilities of *c1* and *c2* given *a1* and *b1*, then given *a1* and *b2*, then *a2* and *b1*, and finally *a2* and *b2*. This is illustrated in figure 7.3. The calculation of the marginal probability of the state *c1* would take the form of the equation in 7.1.

$$
\begin{aligned}
P(c1) = {} & (P(PrA1) * P(PrB1) * P(c1|PrA1, PrB1)) \\
& + (P(PrA1) * P(PrB2) * P(c1|PrA1, PrB2)) \\
& + (P(PrA2) * P(PrB1) * P(c1|PrA2, PrB1)) \\
& + (P(PrA2) * P(PrB2) * P(c1|PrA2, PrB2)).
\end{aligned}
\tag{7.1}
$$

While, theoretically, there is no limit on the number of possible states that a node may have, an increase in the number of possible states will lead to an increase in the complexity of the definitions of its children nodes which may also increase the complexity of the inference needed to propagate the values through a network. The complexity of the definitions of children nodes increases exponentially if a child node depends on two or more parent nodes. This is also where in the current implementation there were major problems encountered with the SMILE and other software packages. Although, these problems were remedied by having the input to the network to be pre-processed in the way described in the following section, this constitutes a real limitation of the Bayesian Networks software packages available to date.

7.3.2 Representing the Situational Component in terms of a Bayesian Network

The topology of the BN used for modelling the Situational Component reflects to a large extent the structure of the component presented in Chapter 6, figure 6.2. Overall, the network consists in 19 nodes, all of which are chance nodes. A chance node is a node in which every state has an equal *a priori* chance of occurring. Such a node differs, for example, from a deterministic node, in which it is assumed that one of a given number of its states will definitely occur. The network, shown in figure 7.4, is organised into levels of nodes, each level representing a stage in the process of making a linguistic decision.

There are altogether four levels of nodes which separate a situation description, provided as the input to the system, from the final classification of the situation in terms of the Autonomy and Approval values which constitute the output of the network. In terms of probabilities, the Autonomy (in the network: *no-guidance*) and Approval values can be also read as the degrees of belief that the Autonomy and the Approval ought to be granted to the student.

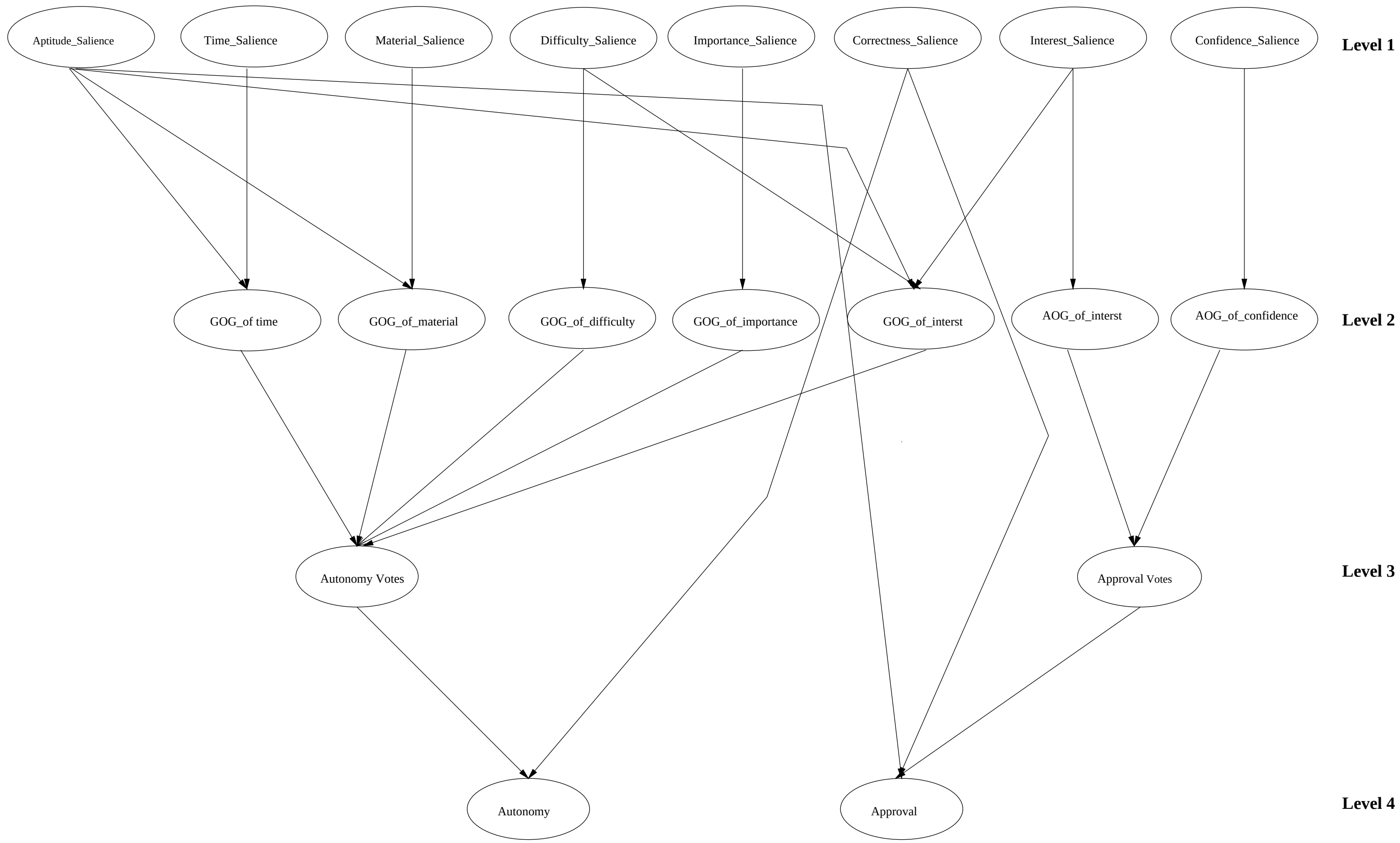


Figure 7.4: The Bayesian Network representation of the Situational Component of the model

7.3.2.1 Level 1: situational factor–salience nodes and the pre-processing of evidence

The first level consists only in the nodes representing the pre-conditions needed for inferring the Autonomy and Approval values. These pre-conditions consist in an information which combines the name of the situational factor that is being modelled (e.g., STUDENT'S CONFIDENCE), its individual values (e.g., *confident* or *not confident*), and the possible saliences (importance rankings) for each of the factor-values (e.g., *v-low*, *low*, *high*, etc.). Example combinations are shown on the left hand side of the table 7.1. Since there is an equal chance that a factor-value pair with a given salience will occur, each state in every top-level node has exactly the same prior, marginal probability. The name of each node represents the information about which situational factor is defined by that node. The states in each node combine the information about the individual values and all of their possible importance rankings. A part of the marginal probability table for the node *Student's Confidence Salience* is given in table 7.1.

Table 7.1: Marginal probability table for the situational factor *Student's-Confidence-Salience*.

Properties of node Student Confidence Salience	
Confi dent v. low	0.055555556
Not Confi dent v. low	0.055555556
Confi dent low	0.055555556
Not Confi dent low	0.055555556
: :	: :
Confi dent high	0.055555556
Not Confi dent high	0.055555556
Confi dent v. high	0.055555556
Not Confi dent v. high	0.055555556

While the importance scale given to the teachers in the study consisted only of five possible rankings (see Chapter 5, figure 5.2), the salience of each factor-value in the BN is represented by nine fuzzy terms with the lowest ranking being *very low (v-low)* and the highest one being *very high (v-high)*. There are two reasons for using the nine fuzzy-linguistic terms. First, because the rankings are properties of the situational factors which, in turn, refer to certain states in which the modelled world may be, the Bayesian Network method dictates that these rankings be represented also as states rather than as probabilities, for instance. On the other hand, the probabilities are used in the definition of each relevant node to indicate the chance of a specific ranking for a particular factor-value occurring, given a concrete situation. Second, while it was possible to have each factor-value ranking correspond to a number on the importance scale used in the study, the numbers 1 – 5 are not fine grained enough to represent the mean values of the actual rankings provided by the teachers in the study. The means are rarely whole numbers such as exactly one or exactly three. Thus, the purpose of the nine fuzzy terms is to have the states capture the fine grained variations in the rankings, while at the same time it is to ensure a finite number of states in every node.

Because each of the two possible factor-values in every of the eight top-level nodes can have nine different fuzzy rankings, in total, every top-level node has 18 different states. When evidence is set on each of the top-level nodes, only one state in the form of a factor-value and its probability is flipped to 1 to indicate that it is currently true. The probabilities of the remaining seventeen possible states in each of those nodes are flipped to 0 which indicates that they are currently false. The evidence to any of the eight top-level nodes consists of the information regarding the exact state in a node that needs to be set to 1. For example, the evidence to the node CONFIDENCE SALIENCE may be *confident-v-low* in which case the current probability of the state *confident-v-low* will be set to 1, while the probabilities of the remaining states will be set to 0. A situation specification along with the concrete salience for each of the factor-values occurring in it constitutes the total evidence to the network.

Evidence for each of the nodes is inferred in the PPU part of the system. The PPU is responsible for pre-processing the raw input to the system which consists of a situation description. A situation description is a list of all the situational factor-values which occur in a given situation. For example a situation description may be something like: APTITUDE: *slow*, TIME LEFT: *plenty*, MATERIAL LEFT: *lots*, DIFFICULTY: *easy*, CONFIDENCE: *not confident*, etc. As was explained before, the PPU consists of two elements: *(a)* a case base CB1 which contains all the situations seen and ranked by the teachers participating in the study, and *(b)* a K-nearest neighbour (KNN) algorithm responsible for searching the case base. For each situation description provided as the input to the system the pre-processing consists in three stages.

In the first stage, the KNN searches the case base for the situation provided as the input to the system. If an exact match is found, the mean rankings for all the individual factor-values in the situations are taken as the evidence to the corresponding eight top-level nodes in the BN. If there is no exact match found, the KNN searches the case base for the nearest three situations. Once these are found, the evidence to the top-level nodes in the network is calculated by deriving the means from the individual means of the factor-values occurring in the three situations. Depending on the actual distance from the input situation, the rankings of the individual values in the three situations may contribute differently to the mean derived for the corresponding factor-values in the input situation.

In the current implementation, the KNN algorithm which is used to do the search for the nearest matching situation, relies on a standard method used in mathematics for calculating distances between vectors. This method is encapsulated in the formula in 7.2.

$$d = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2} \tag{7.2}$$

where, n is the dimension of the search space: specifically in the context of the current model which accounts for eight situational factors, $n = 8$; x_i and y_i are the components of the vectors a and b (where $a = (x_1, x2, ..., x_i)$, and $b = (y_1, y_2, ..., y_i)$); and d is the distance between a and b.

This formula is used to calculate the distances between every input situation and each situation in the case base. When the three nearest situations are selected from the case base, their distances to the input situation are used to calculate the weights of their respective contributions to the mean rankings of the factor-values in the input situation. This is necessary to account for the fact that a situation which is the closest to the input situation should contribute the most to the calculated rankings of its factor-values, while the situation which is the furthest away from it should contribute the least. For example, if one were to assume the three closest situations to be Sit_1, Sit_2 and Sit_3, with the distances $d_1 = 2$, $d_2 = 4$ and $d_3 = 6$ respectively, then the contribution by the factor-values in Sit_1 to the calculated mean ratings of the factor-values in the input situation should be twice as important as the contribution by Sit_2, and three times as important as that by Sit_3. Given that the shortest distance should have the largest weight value, the weights of the contributions by each situation are inversely proportional to their distances.

The weights are calculated by deriving the sum of the three given distances (formula 7.3) and by dividing each sum by the individual distance – equation 7.4. The results of this calculation are then summed, giving a total weight of all three situations (formula 7.5). This total weight is then used in conjunction with the individual weights derived by means of 7.3 to represent the relative importance of the individual weights with respect to each other – formula 7.6. The actual salience of a situational factor in the input situation is simply a sum of the products of the three respective weights and the three saliences of the corresponding factor-values in the closest situations. This calculation is represented in the formula in 7.7.

$$TotalD = d_1 + d_2 + d_3 \tag{7.3}$$

$$w_i = TotalD/d_i \tag{7.4}$$

$$TotalW = w_1 + w_2 + w_3 \tag{7.5}$$

$$RelativeW_i = \frac{w_i}{TotalW} \tag{7.6}$$

$$Salience_f = RelativeW_1 * Salience_1 + RelativeW_2 * Salience_2 + RelativeW_3 * Salience_3 \tag{7.7}$$

The evidence is set on the top-level nodes in the second pre-processing stage. For each node this is done simply by sending a message to the relevant node in the network, which message contains the information regarding the factor-value and the salience inferred by the KNN for the given input situation. However, given that the salience of factor-values in the case base are still expressed in terms of the 1 to 5 scale used in the study, and given that the states of the top-level nodes in the network express the salience in fuzzy-linguistic terms, the two scales need to be consolidated. This is done in two stages. First, the values of 1 to 5 are rescaled to be between 0 and 1 simply by subtracting one from a given salience derived from the study and by dividing it by four. For example, in order to rescale the study ranking 3.2 to correspond to a value on a 0 – 1 scale, 1 is subtracted from it giving the value of 2.2, which is then divided by 4 resulting in the value 0.55.

The third stage consists in mapping the rescaled values onto the fuzzy-linguistic terms. Each fuzzy term is also interpreted in terms of an interval between 0 and 1. The interpretation adopted in the current implementation is given in table 7.2. Given a rescaled salience of a factor-value, the PPU finds the interval to which the rescaled value belongs. For example, the interval to which the rescaled value 0.55 belongs is 0.44–0.55. This is based on the assumption that a value belongs to an interval if it is greater than the lower number in the interval and smaller than or equal to the upper number.

Table 7.2: The mapping of numerical intervals onto fuzzy terms

Fuzzy-term	Interval
0.00–0.12	very low
0.12–0.23	low
0.23–0.34	relatively low
0.34–0.45	low-medium
0.45–0.56	medium
0.56–0.67	medium-high
0.67–0.78	relatively high
0.78–0.89	high
0.89–1.00	very high

7.3.2.2 Level 2: Populating the GOGs and the AOGs nodes

Once the evidence is set on the top-level goals, the values from those nodes are propagated down the network to all of the children nodes. The second level of nodes is used to represent all of the global goals such as GOGs and AOGs evoked by the situation. While explicitly part of the model, the local goals such as LOGs and MOGs are modelled in the BN only implicitly. This is possible because in the model the mapping between the situational factor-values and their saliences, and the local goals is one-to-one. For example, in the current model, the factor-value TIME LEFT: *very little* always evokes the goal *hurry*. This allows for the local goals to be inferred implicitly from the factor-values, thus reducing the complexity of the network. It also reduces the complexity of inference necessary to propagate the evidence through the network. In this implementation, then, the global goals *GOG of time* and *GOG of material* are the children of (i.e., they are caused by) the factor STUDENT'S APTITUDE and the factors AMOUNT OF TIME LEFT and AMOUNT OF MATERIAL LEFT respectively. As will be discussed further on, the rules for combining these factors, presented in Chapter 6, table 6.2, are used for calculating the conditional probabilities of the relevant nodes, the assumption being that *very little time left* and *lots of material left* stands for: *hurry*, while *plenty of time left* and *little material left* means *take time*.

The definition of every node at level two relates to at least one input state and two outcome states. The input states represent the factors which contribute to the definition of a node, the factor-values and their individual salience. The outcome states refer to the possible effects of the input states, while the probabilities express the likelihood that these effects will occur. An example of a (incomplete) definition for a second-level node is given in table 7.3. In the current network, there is a total of 648 entries in this particular table.

Table 7.3: A partial conditional probability table for the GOG of time

Properties of node GOG of time						
Aptitude	slow-v-low		...	fast-v-low		...
Time Left	v-little-v-low	plenty-v-low	...	v-little-v-low	plenty-v-low	...
guide	0.5133	0.4867	...	0.5133	0.4867	...
not guide	0.4867	0.5133	...	0.4867	0.5133	...

Essentially, the definitions of GOGs and the AOGs nodes represent the way in which the input states affect the probability of *guide* and *not guide* and *approve* and *not approve* being the case. The nodes are populated with conditional probabilities using the rules presented and discussed in Chapter 6. The relevant rules contain the information about those factor-values which affect the outcome states positively and those that affect them negatively. For example, in the case of *GOG of time*, the factor-values STUDENT'S APTITUDE: *slow* and AMOUNT OF TIME LEFT: *very little* affect the outcome state *guide* positively, while having a negative effect on the state *not guide*. As was explained in Chapter 6, the rules also contain the information about the relative weights with which the input states affect the outcome states.

Given all the information expressed in the rules, the individual conditional probabilities are calculated on the basis of the salience associated with each input state.

Table 7.4: Mapping from fuzzy terms onto numerical values

Fuzzy-term	Numerical Value
v-low	0.12
low	0.23
rel-low	0.34
low-medium	0.45
medium	0.56
medium-high	0.67
rel-high	0.78
high	0.89
v-high	1.00

Because salience is represented in fuzzy terms, in order to calculate the conditional probabilities, these terms need to be converted back into numerical values. Thus, given a state *slow-v-low* and *v-little-high*, for instance, it is necessary to know to what numerical values *v-low* and *high* correspond before the respective probabilities of *guide* and *not guide* can be expressed given those two states. Although a mapping between the fuzzy terms and the numerical values has been devised for the purpose of calculating evidence for the top-level nodes (see table 7.2), the mapping involves numerical ranges rather than single numbers needed to calculate the prior probabilities. In order to enable these calculations another mapping was devised which allows for the conversion of the fuzzy terms into real numbers. Based on the assumption that the different fuzzy terms are equally likely, the mapping ensures that the numerical values are distributed evenly between the nine fuzzy terms and that each of them is a number between 0 and 1. These mappings are given in table 7.4. An example of how conditional probabilities are actually calculated based on the rules for combining the situational factors – in this case the factors STUDENT'S APTITUDE and AMOUNT OF TIME LEFT – is given in 7.5. The equations in 7.5 calculate the conditional probability of *guidance of time* based on

- **Assumption:** The input states are *slow medium* and *v little rel. high*.
- **Fact:** The table 7.4 indicates that the fuzzy terms *medium* corresponds to the numerical value 0.56, while *rel-high* corresponds to 0.78.
- **Rule:** Rule 1 in table 6.2 in Chapter 6 indicates that: IF *v-little-rel-high* and *slow-medium* THEN Guide with Pr(guidance of time) being calculated based on the equation 7.8
- **Equation:** Given the assumptions above and the equation below, the calculation in 7.9 will result in the conditional probability of the state *guidance of time* given the two input states: *slow-medium* and *v-little-rel-high*

$$Pr(guidanceoftime) = \frac{(\alpha * slow_{medium} + (1-\alpha) * v.little_{rel.high} + 1)}{2} \quad (7.8)$$

where in the current example $\alpha = 0.25$ to express the overall importance of aptitude over time left.

$$Pr(guidanceoftime) = \frac{(0.25 * 0.56 + (1-0.25) * 0.78 + 1)}{2} = 0.8625 \quad (7.9)$$

Figure 7.5: Calculating the conditional probability for the state *guidance of time* given the input states *slow-medium* and *v-little-rel-high*.

the salience of the input states *slow* and *v-little*[time] as determined for them in a given situation by the KNN in the pre-processing unit.

When calculating conditional probabilities for one state, it is also necessary to calculate the conditional probabilities of the other states in the node. In the case of the node *GOG of time*, given that the conditional probability has been already calculated for the state *guidance of time*, the only other outcome state is that of *no guidance of* *time*. The total probability for the states in the node has to be exactly 1. Given this requirement, in order to calculate the conditional probabilities for the remaining outcome state, one could simply subtract the calculated conditional probability for the *guidance* state from 1. However this calculation is not informative with respect to the fact that the input states which contribute positively to the *guidance of time* state, have a negative impact on the probability of the *no guidance of time* outcome. To account for this, it is necessary to perform a reverse calculation, where all of the input states are explicitly shown to have a negative impact on the calculated prior probability of *no guidance of time*. More formally, let $f1$ affect the result with sign $s1$ and $f2$ with sign $s2$. Then:

$$Pr(Goal) = \frac{((\alpha * s1.f1 + (1-\alpha) * s2.f2) + 1)}{2} \tag{7.10}$$

The opposite goal will be affected by $f1$ with sign $-s1$ and $f2$ with sign $-s2$. Thus:

$$Pr(OppGoal) = \frac{((-\alpha * s1.f1 - (1-\alpha) * s2.f2) + 1)}{2}. \tag{7.11}$$

This results in $Pr(Goal) + Pr(OppGoal) = 1$ as required. The actual calculation of the goal *no guidance of time* is shown in equation 7.12.

$$Pr(noguidanceoftime) = \frac{(-0.25 * 0.56 - (1-0.25) * 0.78 + 1)}{2} = 0.1375 \tag{7.12}$$

7.3.2.3 Level 3: Populating the Autonomy Votes and the Approval Votes nodes

The third level in the network consists of two voting nodes: the *Autonomy Votes* and the *Approval Votes* nodes. As was discussed in section 6.2.4 of Chapter 6, voting is a process of combining all of the respective global goals and of inferring the strength with which they should be used in a given situation. This calculated strength is referred to henceforth as the *strength of recommendation* for applying a goal in a given situation. When evidence is set and propagated through the network, the strength of recommendation is calculated for each outcome state in the *Autonomy Votes* and in the *Approval Votes* respectively. The strength is expressed in terms of the posterior probabilities (i.e., probabilities after running the network) of the occurrence of each of the outcome sates in those nodes. The smaller the posterior probability for the positive state, the weaker the recommendation and *vice versa*, the larger the probability, the stronger the recommendation.

The input states to the *Autonomy Votes* nodes are the outcome states of all of the GOG nodes, while the input states to the *Approval Votes* are the outcome states of the two AOGs. The outcome states in the *Autonomy Votes* are *guide* and *not guide*, while the outcome states in the *Approval Votes* are *approve* and *not approve*. The probability table for the *Approval Votes* node is given in table 7.5.

Table 7.5: The conditional probability table for the Approval Votes node

Properties of node Approval Votes				
AOG of intr	approval of intr		no approval of intr	
AOG of conf	approval of conf	no approval of conf	approval of conf	no approval of conf
approve	1	0.5	0.5	0
not approve	0	0.5	0.5	1

Because the *Approval Votes* node is very small, the prior probabilities are entered in its definition by hand. However, because the *Autonomy Votes* node has 32 different entries, to avoid mistakes, the process of populating the node with the prior probabilities is automated. In both cases, all of the contributing votes have an equal impact on the outcome states which is expressed by the weights attached to them. Because the *Approval Votes* node, which has only two inputs, the weights of the inputs which contribute positively to an outcome state is set to 0.5, while the weights of those inputs which have a negative impact on them is set to -0.5. For example, the inputs which contribute positively to the outcome state *approve* are *approval of interest* and *approval of confidence*, while the negative contributions to this state are *no approval* *of interest* and *no approval of confidence*. Because the probabilities represent the goal strengths, the input states are not expected, on the whole, to have the probabilities 0 or 1, but rather they will be a number between 0 and 1. The effect of this rule are the respective posterior probabilities of the states *approve* and *not approve*. For example, given the input state *approval of interest* with the posterior probability 0.8125 and the input state *approval of confidence* with posterior probability 0.875, based on the rule expressed in the node *Approval Votes* which states that two votes for approval should result in the student being approved of, the expected outcome should be the recommendation to approve of the student with the probability that combines the probabilities of the two input states. The performance of the network is in line with the expectation: when the network is run the outcome of the node is the state *approve* with probability 0.865234375 and the state *not approve* with the probability 0.134765625.

In the case of the *Autonomy Votes* node, which has five inputs, the weights for each input state which contributes positively to an outcome are set to 0.2, while the negative contributors are assigned the weight of -0.2. For example the negative contributors for the outcome state *guide* are *no guidance of time*, *no guidance of mat*, *no guidance of difficulty*, etc.

In the case of both nodes, the conditional probabilities for each outcome state are calculated by summing all of the positive and negative contributions.

7.3.2.4 Level 4: Populating the Autonomy and Approval nodes and inferring the final $\langle Aut, App \rangle$ values

The voting nodes constitute the input to the nodes on the fourth and the final level of the network, and hence the *Autonomy* and the *Approval* nodes are the final output nodes in the situational part of the system. Following the structure of the Situational Component presented in Chapter 6, the results of the voting performed on the third level in the network need to be modified further by the relevant situational factors.

In the case of the *Autonomy* node the modifying node is the Correctness-Salience node. Thus, the Autonomy node has two input states: *guide* or *no guide*, and *correct* or *p-correct*, the latter with one of the nine fuzzy salience values associated with it (e.g., *correct high, p-correct-medium*). The respective conditional probabilities for the nodes' outcome states *guidance* and *no guidance* are calculated based on the rules presented in table 6.4 of Chapter 6. An example of a calculation for the outcome state *guidance*, given the input states *guide* and *p-correct-high* is given in figure 7.6.

In the case of *Approval* the modifying nodes are *Aptitude Salience* and *Correctness Salience*. The definition of the node has three input states: *approve* or *not approve*, *slow* or *fast*, and *correct* or *p-correct*, each of the last two types of input states also having one of nine fuzzy salience values associated with them. The node also has two outcome states: *approval* and *no approval*. As was the case with the Autonomy node, the conditional probabilities for the two outcome states are calculated using the rules presented in Chapter 6, table 6.5. An example of a calculation for the outcome state *approval*, given the inputs states, *approve*, *slow-rel-low* and *incorrect-rel-high* is shown in figure 7.7.

The output of the network consists in the posterior probabilities of the outcome states: *guidance* and *no guidance* of the *Autonomy* node, and *approval* and *no approval* states of the *Approval* node. These probabilities are treated by the Linguistic Component as representing the recommendations regarding the amount of Autonomy and the amount of Approval that ought to be given to a student in the situation specified as the input to the system. Because the surface forms in the CB2 are coded with the $\langle Aut, App \rangle$ values which represent the amount of Autonomy (rather than no autonomy) and the amount of Approval (rather than no approval) that they express, only the respective posterior probabilities of the outcome states *guidance* and *approval* are used to find the appropriate surface forms.

- **Assumption 1:** the input states are *guide* and *p-correct-high*
- **Assumption 2:** the weight of the input state: *guide* is 1 indicating that this state is based on the combined votes by five parent nodes each having and equal impact on the voting results which is expressed by the weight of 0.2.
- **Assumption 3:** the weight of the input state: *p-correct* is 0.2 indicating that this state has the same impact on the final Autonomy result as the individual votes of the GOG nodes, but a lesser impact than their combined weight.
- **Fact:** The table 7.4 indicates that the fuzzy terms *high* corresponds to the numerical value 0.89.
- **Rule:** Rule 1 in table 6.4, in Chapter 6 indicates that IF *Guide* and *partially correct* THEN *Guide* with Pr(guidance) being calculated based on the equation in 7.13.
- **Equation:** Given the assumptions and the equation 7.13, the calculations in 7.14 will result in the conditional probabilities for the outcome state *guidance*, given two input states *guide* and *p-correct-high*.

$$Pr(guidance) = \frac{\left(\frac{(W_{guide}+S_{corr}*W_{corr})}{W_{guide}+W_{corr}}\right)+1}{2} \tag{7.13}$$

where $\mathrm{W_{guide}} = 1$ and $\mathrm{W_{corr}} = 0.2$.

$$Pr(guidance) = \frac{\left(\frac{(1+0.89*0.2)}{1.2}\right)+1}{2} = 0.9908 \tag{7.14}$$

Figure 7.6: Calculating the conditional probability of the outcome state *guidance* given *guide* and *p-correct-high*

- **Assumption 1:** the input states are *approve* and *slow-rel-low* and *incorrect-rel-high*.

- **Assumption 2:** the weight of the input state: *approve* is 1 indicating that this state is based on the combined votes by two parent nodes each having and equal impact on the voting results (expressed by their respective weights of 0.5).

- **Assumption 3:** the weight of the input states: *slow-rel-low* is 0.25 indicating the relatively low impact on the final approval, while the weight of the input state: *incorrec-rel-high* is 0.75 indicating a much higher than that of aptitude impact on the amount approving needed in the given situation (See Chapter 6, table 6.5, for justifications of the weights).

- **Fact:** The table 7.4 indicates that the fuzzy terms *rel-low* and *rel-high* correspond to the numerical values 0.34 and 0.78 respectively.

- **Rule:** Rule 1 in table 6.5, in Chapter 6 indicates that IF *Approve, slow* and *incorrect* THEN *Approve* with Pr(approval) being calculated based on the equation in 7.15.

- **Equation:** Given the assumptions 1–3 and the equation 7.13, the calculations in 7.16 will result in the prior probabilities for the outcome state *approval,* given three input states *approve slow-rel-low* and *incorrect-rel-high*.

$$Pr(approval) = \frac{\left(\frac{(W_{appr} - S_{apt} * W_{apt} - S_{corr} * W_{corr})}{W_{appr} + W_{apt} + W_{corr}}\right) + 1}{2} \tag{7.15}$$

where $\mathrm{W_{appr}} = 1$, $\mathrm{W_{apt}} = 0.25$ and $\mathrm{W_{corr}} = 0.75$

$$Pr(approval) = \frac{\left(\frac{(1 - 0.34 * 0.25 - 0.78 * 0.75)}{2}\right) + 1}{2} = 0.44375 \tag{7.16}$$

Figure 7.7: Calculating the conditional probability of the outcome state *approval* given the input states: *approve*, *slow-rel-low* and *incorrect-rel-high*

7.4 The implementation of the Linguistic Component of the model

Once the $\langle Aut, App\rangle$ values are inferred in the situational part of the system, these values can be used to find the surface forms which are judged by the system as suitable for a given input situation.

The linguistic part of the system consists in two components: the case base: CB2, and the K-nearest neighbour (KNN) inference mechanism. The case base contains 36 different surface forms which are coded manually for Autonomy and Approval values based on the guidelines devised and presented in Chapter 6. All of the surface forms come from the Pittsburgh dialogues and are one teacher's responses to either incorrect or partially correct actions by various students. They are listed in Appendix D. The surface forms were selected in such a way as to represent all of the different strategies discussed in Chapter 6.

When the calculations of Autonomy and Approval values are completed by the BN, the KNN retrieves these values and compares them to the ones which are associated with the surface forms in CB2. The search that the KNN performs is based on the same principle as the search done by the KNN in the situational component and which is encapsulated in equation 7.2 (see section 7.3.2.1, page 252 for a detailed explanation).

The output of the linguistic part of the system also constitutes the output of the system overall. It consists in the recommendation of the linguistic response which is coded for the Autonomy and Approval values judged by the system to be the closest to those which are passed to this component by the BN. The system also allows for several different recommendations to be selected for one situation and the user has the option of selecting the desired number of different recommendations. These different recommendations are ordered from the closest matching ones to the furthest matching one. For each recommended form the distance from the desired $\langle Aut, App\rangle$ values is displayed. Furthermore, for every input situation the system shows a less preferred response recommendation which is coded for $\langle Aut, App\rangle$ values falling approximately half way between the closest and the furthest match in the Case Base.

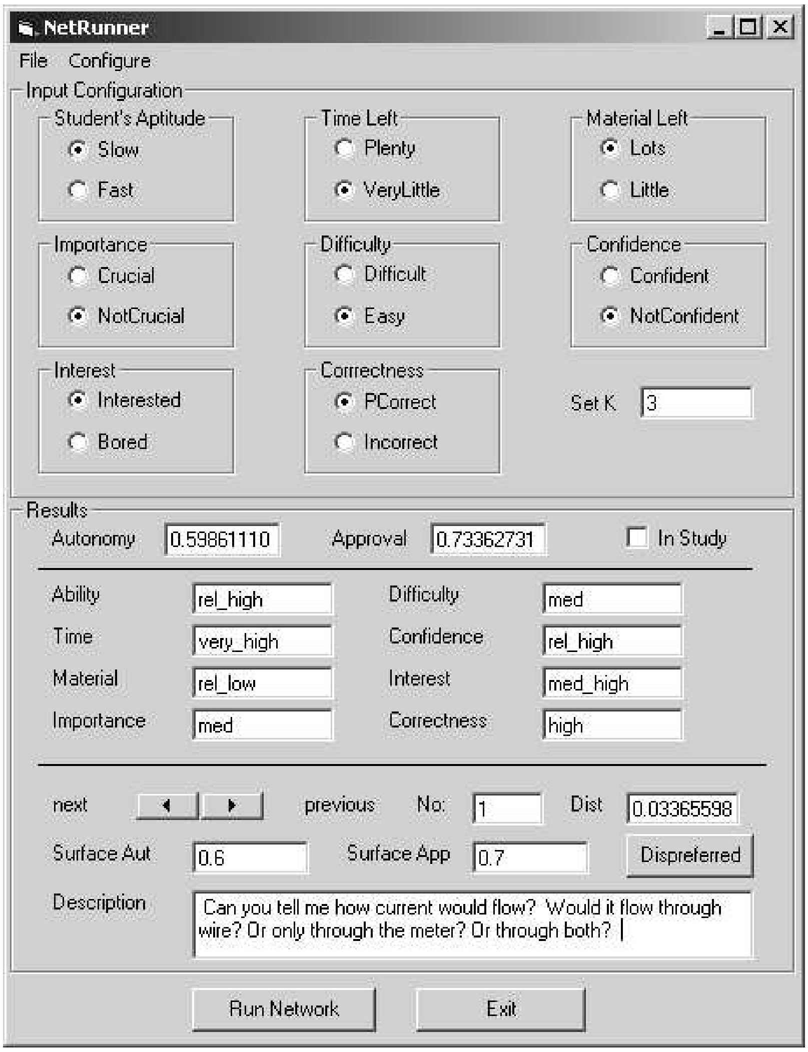
7.5 An Example of the System in Use

When the system is loaded the user is presented with an interface which allows him to select the appropriate situational factors, to run the system, and to view the results including the evidence that has been set on the input nodes in the BN, the Autonomy and Approval values of the recommended form, the distance of the $\langle Aut, App\rangle$ of recommended form from the values calculated by the BN, and the actual surface form. In the case of a request for a number of different forms to be recommended by the system, the interface allows one to browse through the different recommendations. For each surface form recommended the user may, if he wishes, select the *"dispreferred"* button which will cause the less preferred response to be displayed. The entire interface is shown in figure 7.8.

In the current example, the specified situation consists in a student whose progress is *slow*, whose *confidence is low*, but whose *interest is high*. The student's previous action was *partially correct*. The *material taught is easy* and *not crucial*, the *time is short* and there is *a lot of material* still to cover. The user also chose the option *"Set K"* and asked the system to find 3 response recommendations.

In the *"Results"* part of the window, the user is informed of several things. First, he is informed of what Autonomy and Approval values were calculated for the situation he specified. The little window marked *"In Study"* informs one whether or not the situation was already in the CB1: if the window has a tick "$\surd$" in it, this means that the saliences for each of the situational factors represent the results of the study with teachers directly. If the window is empty, as is the case in the current example, this means that the saliences had to be calculated for the input situation based on the 3 closest situational matches found in CB1. The saliences displayed in the *Results* part of the window represent the mean saliences of the 3 situations used. These saliences along with factor-values specified by the user constitute the input (the evidence) to the top-level nodes in the BN. An example of the effect that setting the evidence on the

Figure 7.8: The system's interface



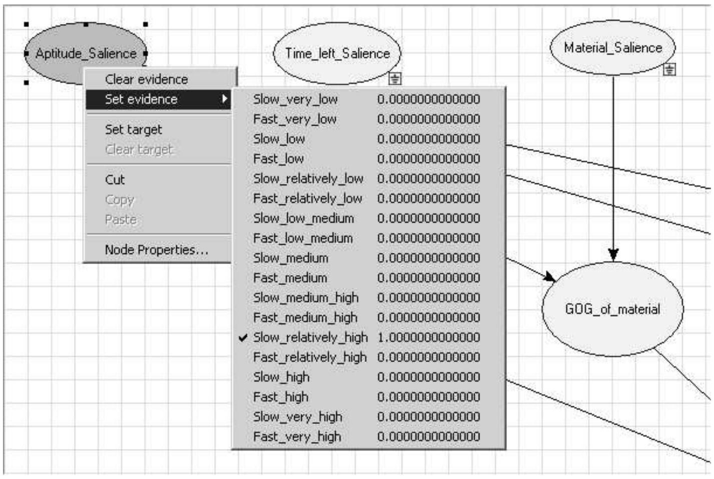


Figure 7.9: The effect of evidence being set on the node Aptitude Salience

Aptitude Salience node, for instance, has on the values in that node is given in figure 7.9.

As can be seen in figure 7.9, there are 18 states to which this node can be potentially set. In this case, as is indicated in the figure 7.8, the input for the Aptitude is *slow-rel-high*, which is reflected in the evidence shown in figure 7.9: the state *slow-rel-high* is flipped to TRUE (1), while the rest of the states are flipped to FALSE (0). The evidence of all input nodes in the network is set in exactly the same manner.

Once the evidence on the input nodes is set, the network can be run and the evidence can be propagated through it. For each node in the network, the outcome of the propagation of evidence is based on the conditional probabilities in terms of which each node is defined. The results of running the network are shown in figure 7.10 for two levels of nodes leading to the calculation of the Autonomy values.

The results shown in figure 7.10 are those of the *GOG of difficulty*, and the *Autonomy Votes*. Since, in the case of the Autonomy values, CORRECTNESS of the student's previous actions is used to modify the results of voting, the node and its current status are also shown in the right hand side of the figure. The posterior probabilities of the node *GOG of difficulty* represent the amount of *guidance* and *no-guidance* recommended by this node in the specified situation. Thus, there is a clear vote by this node for relatively little guidance (Pr(*no-guidance*) = 0.75), based on the fact that the difficulty of material in the current situation is low (i.e., the material is easy). However, since there are four other voting nodes which contribute equally to the overall outcome of the node *Autonomy Votes*, the recommendation of that node with respect to *guidance* and *no-guidance* respectively is almost half and half, with the recommendation for giving the student the autonomy being slightly less than for providing him with guidance (Pr(*no-guidance*) = 0.4916).

The results of the Autonomy voting are further modified by the correctness of the student's previous action which was partially correct. The partial correctness of the student's answer leads to an expectation that the recommendation for giving the student autonomy should be more than suggested by the *Autonomy Votes* node. If the student's answer were incorrect, the expectation would be that the strength of the recommendation for guidance would increase. Indeed the expectations for this particular example are confirmed by the outcomes of the node *Autonomy* (Pr(*no-guidance*) = 0.5986). This is shown in figure 7.11 where, for completeness, the outcomes of the Approval node are also shown. The results of both nodes are consistent with those displayed in the *"Results"* part of the window in figure 7.8. As was explained earlier in this chapter, only the recommendation for the goal *Don't guide* (in the BN *no-guide*), and of *Approve* are passed on to the linguistic component of the system. In this case the results are in line with the expectations that one could have with respect to the input situation. Thus, the fact that the networks recommendation is to give the student a bit of Autonomy can be traced to the fact that the topic is neither difficult nor crucial. On the other hand, that the recommendation does not call for full or even high amount of

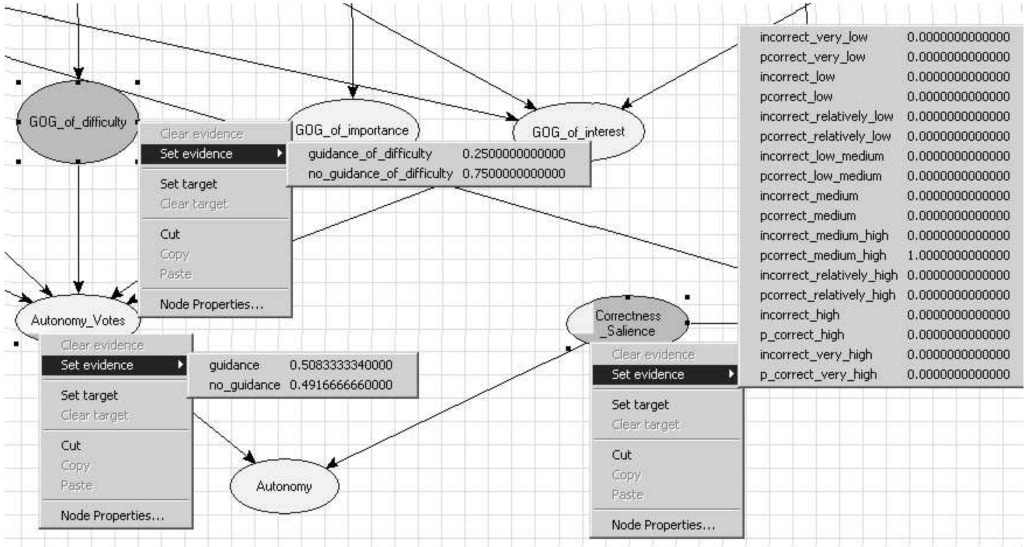


Figure 7.10: Some of the results of the propagation of evidence through the network

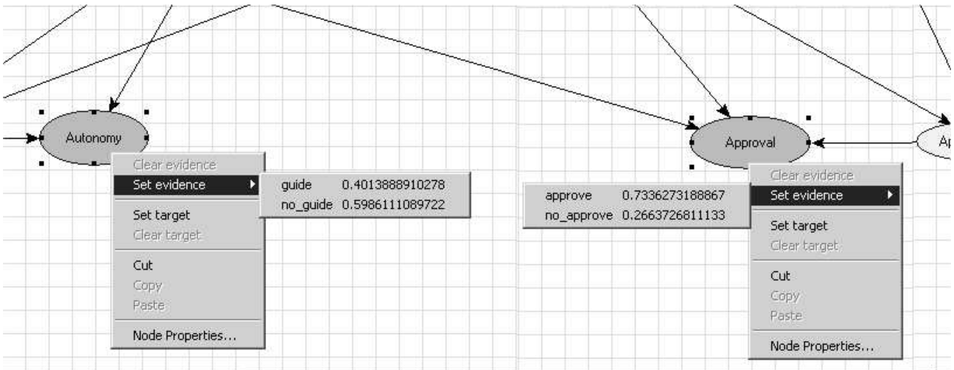


Figure 7.11: The outcomes of the *Autonomy* and *Approval* nodes

Autonomy can be traced to the fact that the student is not progressing *slowly*, as well to the temporal constraints such *a lot of material* left to cover in *little time*.

The results of the Approval node can also be explained based on the input situation. The final recommendation is to give a considerable amount of approval to the student (Pr(*approve* = 0.7336). This is because the student is *not confident*, but at the same time he seems engaged in the lesson (i.e., the student seems *interested*). The fact that his answer was *partially correct* rather than incorrect also calls for a certain amount of approval especially in the face of his lack of confidence which needs to be boosted and in the face of his high interest which needs to be maintained. On the other hand, the recommendation for Approval is not the highest possible one due to student's *low aptitude*.

The values of the states *no-guide* and *approve* are passed on the KNN within the linguistic component of the system. These values are used to search the CB2 for those responses of which the Autonomy and Approval values correspond most closely to them. The result of the nearest neighbour search is displayed in the *"Results"* window of the user interface, along with the distance between the Autonomy and Approval values associated with a given response and the values calculated by the BN. In the current example, the match is not exact, but the distance between the two sets of values is minimal (d = 0.0336...). The responses recommended by the system are displayed in the interface window one by one and they are numbered according to how closely they match the values recommended by the network. To view all the recommendations, the user is provided with the *"next"* and *"previous"* buttons, which takes him through all the options available. The *"dispreferred"* button is provided for the purpose of viewing the response which is less preferred by the system.

7.6 Summary

In this chapter the details of the implementation of the model were explained. The situational component was implemented using a combination of a Case Based Reasoning and Bayesian techniques, and the way in which the nodes in the network are populated with conditional probabilities was explained. The use of Bayesian Networks was motivated by the complex, non-discrete nature of speech acts and their categories as well as the need for a method that would allow to characterise a situational context in numerical terms to be used to map onto the corresponding numerical values associated with the available linguistic forms. Bayesian Networks not only offer an efficient way in which to store complex data, but also a way of performing inference efficiently.

The implementation of the linguistic component consists in a case base in which 36 surface forms found in the Pittsburgh dialogues are stored. The forms are coded for Autonomy and Approval values based on the method described in Chapter 6. The Bayesian Network calculates the values of $\langle Aut, App \rangle$ based on the input situation description, which values are passed to the linguistic component in which the nearest neighbour search of the case base containing the surface forms is performed. The recommendations of the linguistic component consist in those surface forms of which the Autonomy and Approval values match most closely the values calculated by the Bayesian Network. A detailed example of the system in operation was given in section 7.5.

The following chapter presents a formative evaluation of the system and the summative evaluation of the system and of the model.

Chapter 8

The Evaluation of the Model

8.1 Introduction

This chapter presents the evaluation of the model described in Chapter 6. Since the design and the implementation of the system follows that of the model, the system is used as a tool for simulating the behaviour of the model in producing linguistic response recommendations given a particular set of situational parameters. The linguistic recommendations are then evaluated according to their appropriateness for the given situations by human experts. Given that the model is intended to be embodied by the system, two types of evaluation were needed to ensure a fair judgement of the model's validity. The first type – the formative evaluation – was needed during the design and implementation of the situational component to ensure the component's consistency with the model. It was also to ensure the consistency of the method for assigning the Autonomy and Approval values to surface forms. The summative evaluation conducted after the completion of the formative stage constitutes the second type of evaluation. Its purpose is to assess the appropriateness of the linguistic output of the model given a set of situations as inputs as compared with the linguistic responses produced by human tutors in the corresponding situations.

The two parts of the formative evaluation are described in section 8.2, with the evaluation of the situational component being presented in subsection 8.2.1, and that of the linguistic component – in subsection 8.2.2. The study carried out for the purpose of evaluating the model summatively is presented in section 8.3.

8.2 The Formative Evaluation

The formative evaluation was conducted throughout the design and the implementation of both the situational component and of the linguistic component. The purpose of this form of evaluation was to ensure that the system embodying the model was indeed implementing it and that it was behaving according to certain intuitively defined expectations as to the types of output given particular inputs. While the evaluation of the situational component was conducted mainly by observing the output of the Bayesian Network, the evaluation of the linguistic component was done both manually over a period of several months as well as on the basis of observing the mappings between the actual concrete input situations and the linguistic output produced for those situations by the system during the development phase.

8.2.1 The evaluation of the situational component

Due to the multidimensional nature of the situational component inputs, it did not lend itself to a precise form of evaluation. It was virtually impossible to assess the appropriateness of the $\langle Aut, App \rangle$ values for each individual situational input, because many of the situations differed only minimally from each other. For example, to have to reflect the difference between situations such as the ones in table 8.1 in terms of exact numbers would have been a very arbitrary and unsatisfactory undertaking.

Instead, ensuring that the model was behaving reasonably involved examining the following:

1. The probability tables which resulted from applying the rules for combining different factors.

Table 8.1: Example situations for showing the possible difficulties with assigning precise $\langle Aut, App \rangle$ values

Factors	**Situation 1**	**Situation 2**
Time Left :	Very little	Very little
Amount of material left :	Plenty	Plenty
Difficulty of Topic :	Difficult	Difficult
Importance of Topic :	Crucial	Crucial
Correctness of S' answer :	Incorrect	Incorrect
S' Ability :	Slow	Fast
S' Confidence :	Not confident	Not Confident
S' Interest :	Bored	Bored

2. The overall spread of salience values across the range from very low to very high, and of the final Autonomy and Approval values output by the network across the 0 to 1 range.

The appropriateness of the probabilities of the individual nodes in the network was assessed based on the rules for combining the factors affecting the given nodes. For example, as was explained in Chapter 7, the node *GOG of time* has two states: *Guide* and *Don't guide*. The combination of the factors ABILITY and AMOUNT OF TIME LEFT along with their salience expresses the pre-conditions of the relevant rules, e.g. IF ABILITY: *slow* with salience S_1 and AMOUNT OF TIME LEFT: *very little* with salience S_2 ... . The probabilities which are needed to fill the cells corresponding to the node's two states are calculated based on the conclusion of the rule, e.g. ...THEN $(\alpha * S_1 + (1-\alpha) * S_2 + 1)/2$, where α refers to the impact I that S_1 and S_2 ought to have on the resulting probability. The rules for combining situational factors inform the model as to the factors and the nature of the impact that these factors have, i.e. positive or negative, on the probabilities of the individual states. In the case of the factor-values *slow* and *very little time left*, the factors contribute negatively to the state *Don't guide* and positively to the state *Guide*. In this case then, given the input states *slow* and *very little time* when examining the probability tables the correct behaviour embodied by the probabilities of the node *GOG of time* requires for the numbers of the state *Guide* to be higher than those of *Don't guide*. This check was the standard, primary method used for debugging the system.

Apart from having to be checked for consistency in terms of the prior, conditional probabilities, the behaviour of the situational component needed to be checked with respect to the input to the network and consequently with respect to the output that the network actually produces. Ultimately, the purpose of this check was to ensure that the Autonomy and Approval values output by the network did not cluster around one area of the range, e.g. around the middle, but rather that the values were spread across the entire range, thus facilitating the selection of different linguistic responses. The check was all the more necessary given that not all the input to the network was known a priori. Given that only 54 situations were actually seen by teachers in the study presented in Chapter 5, only the salience of factors in those 54 combinations were known. For the rest of the 256 combinations the salience values had to be inferred, and in the system evaluated here this was done using a K-nearest neighbour algorithm.

In order to check for the spread of the salience values across the whole range from very low to very high, a program was written which summarised the input from all 256 possible situations. This summary is shown in table 8.2. The resulting lowest and highest possible Autonomy and Approval values output by the network are shown alongside the salience values summary. The numbers in the summary indicate the number of situations in which the fuzzy salience values, listed on the left hand side of the table, were input to the network. As can be seen very few *very low* and *low* values are input to the network. This results in the lowest Autonomy and Approval values falling relatively high above the lowest possible value of 0. By far the most common values are *medium high* and *relatively high* with a decreasing number of cases appearing in the highest end of the range. This explains the lack of Autonomy and Approval values higher than 0.8 and 0.88 respectively.

In terms of improving the output of the network, the values that are shown in table 8.2 are the best that they can get based on the limited data currently available. The

Table 8.2: The spread of salience values across all 256 possible situational factor-value combinations.

Salience	Ability	Time	Material	Importance	Difficulty	Confidence	Interest	Correctness
very low	0	0	1	0	0	0	1	0
low	0	0	2	0	0	0	0	0
relatively low	0	2	28	1	1	1	0	3
low medium	2	10	70	11	15	0	1	18
medium	11	45	69	43	44	14	24	46
medium high	56	56	47	48	68	61	55	67
relatively high	85	67	23	90	94	94	110	78
high	78	64	11	51	32	66	55	40
very high	24	12	5	12	2	20	10	4

	Autonomy	Approval
Min	0.275174	0.206
Max	0.800347	0.889671
Average	0.534589	0.589934
Variance	0.0206	0.0309

values reflect the results of the study presented in Chapter 5 and therefore altering them would result in arbitrary and unjustifiable choices. However, despite the fact that neither Autonomy nor Approval values reach the lowest or the highest possible values in the range, the spread of values is sufficiently wide to allow for diverse mappings to be made between the output from the situational component and the surface forms in the linguistic component of the system.

8.2.2 The evaluation of the linguistic component

The main and the most important indication of the validity of the linguistic component can be obtained only as a result of the summative evaluation in which the linguistic output of the model is assessed by real, experienced tutors. This is done in section 8.3. However, at the formative level the method for calculating and for assigning the values to the individual strategies and surface forms needed to be checked at least with respect to its *stability*. A stability test, also known as *intra-observer reliability* or *consistency* test, is the weakest form of evaluating the reliability of a coding system or method. It is the weakest method because it does not ensure either reproducibility of the coding method by independent coders nor does it guarantee accuracy. The test is performed under *test-retest* conditions whereby the same coder codes "the same set of data twice at different points in time" (Krippendorff, 1980, p.130). Essentially the purpose of the test is to account for the possible inconsistencies in one coder's decisions. Since the formative evaluation was to be followed by the summative evaluation in which the judgements by real tutors would indicate the accuracy of the coding method, and since no independent coders were expected to use the method during its development, only the stability test was applied.

A set of 36 surface forms corresponding to some of the responses of the Pittsburgh tutor to various students' incorrect and partially correct actions were coded by the author for Autonomy and Approval values based on the method described in Chapter 6, section 6.3.1.2. The coded surface forms were re-coded twice in the space of 1 month with the first re-coding taking place approximately two weeks from the original coding, and the second re-coding taking place approximately a month after the first one. The first re-coding resulted in changes to Autonomy and Approval values to most of the 36 surface forms. This was due primarily to the changes that the author made to the basic values which she originally associated with the auxiliary strategies. For example, originally no different Autonomy or Approval values were assigned to various hedges used by teachers: *still* had the same value as *actually*, for instance, which during the second coding, and after a further re-examination of the linguistic data was judged by the author as inaccurate. This was because the hedge *actually* was found to be used by a teacher typically as a prefix to the actual answer or at least part of it, while *still* was typically found in cases where the tutor did not give the answer away to the student. By virtue of this observation the coding method was made more sensitive to the differences between different realisations of the hedging as well as other auxiliary strategies.

The second retest resulted in the Autonomy and Approval values being consistent with the ones calculated during the first re-coding. Because of this, the surface forms coded for Autonomy and Approval were judged as suitable for final evaluation.

8.3 Summative Evaluation

In order to evaluate the model summatively an evaluation study was designed to test for the appropriateness of the linguistic output produced by the system for different situations. The information sought by the study concerns primarily the overall quality of the model's performance. In particular the evaluation seeks to answer the following three questions:

1. How does the system's preferred linguistic output compare overall with the human tutor's responses?
2. How does the system's less preferred linguistic output compare overall with the human tutor's responses?

3. Are the system's preferred and dispreferred responses perceived as better and worse respectively by the experienced human tutors?

8.3.1 Participants

Four very experienced lecturers and tutors from Edinburgh University participated in the study. All of them were experts in tutoring basic electricity and the electronics domain and all of them volunteered to take part in the study.

8.3.2 Materials and Procedure

The materials consisted of four sets of five dialogues between a tutor and a student. The dialogues were based on real exchanges between the Pittsburgh tutor and different students, but they were adapted by the author to represent different situations in terms of the eight situational factor-values included in the current model. While some of the factor-values were made explicit within the teacher's initiating comments, for example the fact that there was little time left was expressed by the teacher saying something along the lines of: *"OK, we are running out of time, so we need to try to concentrate a bit harder now"*, other factor-values were included in parentheses next to the teacher's or the student's turn. An example of a dialogue included in the materials is given in the figure 8.1.

In total twenty different dialogues representing twenty different situations were tested by the study. In the first instance, each participant was given two sets of dialogues (a total of ten). After completing the two sets, the participants were given an option of either continuing with the remaining two sets, or of ending the session. All of the participants attempted all four sets.

The situations were selected with two constraints in mind:

1. For all the twenty dialogues selected ten of them had to end with a student incorrect answer and ten with a student partially correct answer.

Dialogue 4 (D.4.1)

Teacher: You're doing really well, we still need to clarify a few simple things which are nevertheless important.

Teacher: Since we're running out of time, can you briefly explain how to observe polarity?

Student *(interested)*: Yes, that's just making sure the positive wire is connected to the positive side and vice versa (CORRECT)

Teacher: OK, then, if the red lead were connected to the tab number 3 and the black lead to number 4, which tab positions would be included in the negative side of the circuit?

Student *(confident)*: the number 4 tab, of course. (PARTIALLY CORRECT: *the negative side of the circuit would span from tab 3 to 6*)

Figure 8.1: Example dialogue used in the evaluation study

2. When translated into situational factor-values no two situations were allowed to be identical.

These constraints were to ensure that the study evaluated the appropriateness of the linguistic outputs across a reasonably wide sample of different inputs to the model.

The rest of the input selection consisted of a randomly chosen combination of factor-values which the author then kept changing until twenty different combinations were selected.

The last turn in each dialogue consisted in a student incorrect or partially correct answer. Each such answer was followed in the materials by three possible follow-up responses by a teacher. As an example of this the responses to the dialogue in figure 8.1 are shown in figure 8.2. One of the three responses was by a real human tutor who was an expert in tutoring the basic electricity and electronics. During the construction of the materials, the tutor was asked to provide responses to all twenty situations. To ensure that the dialogues were easily interpretable by other tutors in terms of the situational factor-values intended by the author, after providing the follow-up responses to the twenty dialogues, the human tutor was asked to describe the dialogues in terms of the eight situational factors used in the model.

CHOICE 1 **Teacher:** You are right that tab 4 would be on the negative side of the circuit, but is it the only one?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** What gives you the idea that tab 4 is on the negative side of the circuit?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** That's true. Are there any other tabs in the negative side of the circuit?

Not appropriate	1	2	3	4	5	V. appropriate

Figure 8.2: Example responses to be rated in terms of appropriateness for the dialogue in 8.1

The other two responses included in the materials were provided by the system: one response was the system's most preferred one and was selected on the basis of the K-nearest neighbour algorithm discussed in the previous chapter. The other response was the one of the system's less preferred responses. It was selected on the basis of an algorithm implemented solely for the purpose of the current evaluation. Instead of leading to a selection of responses of which the Autonomy and Approval values matched most closely those calculated on the basis of the input situations, the algorithm selected responses for which the two values fell half-way between the best and the worst match. Because the system can only select from a set of fully formed sentences which were included into the case-base directly from the Pittsburgh dialogues, all of the system's output had to be adjusted manually with respect to the content to reflect the content of the given dialogue. The output was adjusted based on the examples from the Pittsburgh dialogues.

Each of the three responses was accompanied by an *appropriateness* scale with values between one and five, where the value of 1 corresponded to *not appropriate* and the value of 5 corresponded to *very appropriate*. The participants were asked to use the appropriateness scale to rate each of the three follow-up responses according to how appropriate they found them as responses to a student's erroneous answer in a given situation. The participants were not told until after completing the study how the three responses were produced, the implication being that they were all produced by a human.

The order in which the three responses were presented to the participants varied from dialogue to dialogue, i.e., it was not always the case that, for example, the human response was first, followed by that preferred by the system, followed by the dispreferred response. Also, although they were presented with the same dialogues, the different participants saw the dialogues in different order. The reason for varying both the order of the follow-up responses and the order of the dialogues was to avoid a possibility of a bias in the final ratings.

8.3.3 Results

An analysis of variance of ratings of the three follow-up responses was carried out using participants and dialogues as random factors F1 and F2 respectively. The conditions were the *correctness* of student answer which could either be incorrect or partially correct, and the *response type*, i.e. human, system's preferred and system's less preferred response.

The F1 (by participant) analysis revealed a difference between the correctness instances in that overall, i.e. across different types of follow-up responses, participants rated the responses to student partially correct answers higher than the responses to student incorrect answers (2.99 vs. 2.46 respectively; $F1(1,3) = 82.17; p = 0.003$). The analysis also shows a main effect of response type in that the participants rated the three follow-up responses as different (human response: 3.33, less preferred system's response: 2.01, preferred system's response: 2.83; $F1(2,6) = 17.47; p = 0.003$). However, there seems to be no interaction between these two variables and thus the ratings for the three responses are consistent across student partially correct and incorrect answers.

The F2 (by dialogue) analysis was in line with the F1 analysis showing a main effect of correctness ($F2(1,18) = 9.41; p = 0.007$), and a main effect of response type ($F2(2,36) = 11.95; p < 0.001$), with no interaction between the two variables.

Because correctness of student answer did not interact with response type, the data were analysed together in a post-hoc analysis. The post-hoc analysis consisted in the paired t-test and relied on the adjusted alpha ($\alpha = 0.05/3 \simeq 0.0167$) to account for the fact that given the comparison of three types of responses, three post-hoc tests were needed.

Due to the small number of participants the post-hoc, by-dialogues analysis (t2) is considered to be more indicative of the model's performance than the by-participant (t1) analysis [1]. The by-dialogue analysis revealed three very encouraging effects. First, predictably, it showed a significant difference between human follow-up responses and system's less preferred responses ($t2(19) = 4.40, p < 0.001$). Second, it showed a significant difference between system's preferred and system's less preferred follow-up responses ($t2(19) = 2.72, p = 0.013$). Third and most unexpectedly, the analysis showed no significant difference between human follow-up responses and the system's preferred responses ($t2(19) = 1.99, p = 0.061$)! What this means is that while the system's less preferred responses are perceived by human tutors also as less appropriate for the given situations, on the whole the system's preferred responses are perceived by the same participants as not significantly different from the human responses.

A "by-eye" comparison of the mean ratings for the individual dialogues across participants shows that, marginally (12 out of 20 dialogues), in most cases the ratings for the human responses are higher than those for the system's preferred and system's less preferred choices. In table 8.3 which shows the mean ratings of the three responses, the dialogues in which the human responses were rated higher than the other two response types are marked with a single asterisk "*". Also such comparison confirms the results of the "by-dialogues" post-hoc analysis in that it shows that the majority

[1] The by-participants analysis showed no significant differences between any of the three groups of responses. Thus there was no difference between human and system's less preferred responses ($t1(3) = 4.63, p = 0.019$); there was no difference between human and system's preferred responses ($t1(3) = 3.74, p = 0.033$); and no difference between system's preferred and less preferred responses ($t1(3) = 3.55, p = 0.038$).

of the system's less preferred responses were rated lower than the system's preferred choices (14 out of 20 cases). These are marked with a tick "$\surd$". All of the materials used in this evaluation are included in the Appendix C. The numbers corresponding to the dialogues numbers in table 8.3 are indicated in the appendices in bold and in parantheses.

In one out of twenty cases the system's preferred and the system's less preferred responses were rated the same (this is indicated by a single cross "x"); in five cases the system's less preferred responses were rated higher than the system's preferred choices, and in three out of those five cases they were rated higher than the human responses (indicated by two crosses "xx").

Most of the problematic cases (3 out of 5) which include dialogues 16, 17 and 18, are the dialogues which the participants found problematic in terms of the content and in terms of its argument structure. Neither the content nor the argument structure had been changed from the original dialogue samples found in the Pittsburgh dialogues. Despite the problems, the participants "pretended" that the dialogues were correct and they rated the three responses as best they could. It is very likely, and it is something that all of the participants remarked on during the post-hoc discussion about the study, that the incorrectness of the dialogue content affected the participant's judgements with respect to the follow-up responses to those dialogues. It is interesting that in all three cases the system's less preferred responses were rated also higher (in 2 cases) or the same as the human responses, which may suggest that the human tutor who helped in the preparation of the materials experienced the same problems with the aforesaid dialogues as did the tutors taking part in the study [2].

The explanation for the two remaining cases – dialogues 14 and 20 – is less readily available. In the case of dialogue 14 the system's less preferred response is by far the most highly rated one of all responses, followed by the system's preferred response, finally followed by the human response. A closer look at the types of responses

[2] Unfortunately, although the tutor who helped in the construction of the materials indicated that these dialogues may be problematic in terms of the content, he did not seem to have perceived them as completely wrong as did the tutors taking part in the study. Had the seriousness of the problem been communicated to the author, different dialogue samples would have been used instead.

Table 8.3: Means for individual situations across participants

	Dialogue	Student's answer	Human	System's less preferred	System's preferred
√ *	1	incorrect	4.500	1.250	2.250
√ *	2	incorrect	4.000	2.000	2.750
√ *	3	incorrect	3.000	1.250	2.500
√ *	4	incorrect	3.000	1.250	1.250
√ *	5	incorrect	3.250	1.500	1.750
√	6	incorrect	2.000	1.000	4.000
√ *	7	incorrect	3.750	1.500	3.500
√	8	incorrect	2.500	1.750	3.250
x *	9	incorrect	2.750	1.500	1.500
√ *	10	incorrect	4.250	1.250	3.750
√ *	11	partly correct	4.500	2.250	4.250
√	12	partly correct	3.000	1.750	3.250
√ *	13	partly correct	3.500	2.500	2.750
xx	14	partly correct	2.000	4.000	2.500
√ *	15	partly correct	4.333	2.000	3.667
xx	16	partly correct	3.333	3.667	3.333
xx	17	partly correct	3.333	3.333	2.333
xx	18	partly correct	2.333	3.333	2.333
√	19	partly correct	3.000	1.500	4.000
xx *	20	partly correct	4.000	2.250	1.750

(shown in 8.1) given for this situation suggests one possible explanation of this result: in comparison to the system's responses, the style of the human response seems long and convoluted, which may have been perceived by the participants as not reflecting a good tutoring style. Indeed, one of the participants explicitly marked this human response as unacceptable not only by giving it the lowest score, but also by writing "eek!" next to it.

(8.1)

(a) You are right that tab 4 is on the negative side of the circuit. But is it the only tab on that side? (*system's dispreferred*)

(b) You are on the right track. Tab 4 is on the negative side of the circuit. But there are other tabs which belong with tab 4. Can you guess which ones? (*system's preferred*).

(c) Good. That's certainly on the negative side of the circuit. So you've found one position. What, if you like, is the 'most negative' point in the circuit, or better perhaps, the last possible negative point in the circuit? (*human response*)

In terms of the rating for the dispreferred response in dialogue 14 being higher than that for the system's preferred response, it is possible that the latter appeared unnecessarily long-winded to the participants. The character of the system's preferred response was determined largely on the basis of the fact that the student was not confident. In such cases, other factor-values permitting, the model predicts that the answer is likely to be more wordy and reassuring to the student which is exactly what the system's preferred response is. However, it is possible that the Approval values for this particular response are slightly too high in comparison with the system's dispreferred response and that the calculation responsible for this assignment requires to be adjusted appropriately. On the other hand, because the calculation method has been devised with other than just the basic electricity and electronics domain in mind, it would be useful to compare the rating of similar types of responses to the same situations in other domains to eliminate the possibility that these particular ratings have not resulted from the style of tutoring imposed by the domain.

Finally in the case of the dialogue 20, an explanation is possible as to why the system's less preferred response was overall more preferred than the system's preferred choice. In this case there were also problems with the content – this time the adjusted content of the follow-up responses. Here the student's answer was only partially correct based on the fact that one does not refer to electricity flowing through a circuit, but rather one uses the term "electrons". The implication of both the system's preferred and the less preferred responses was that the student's mistake was in believing that electricity flows through the circuit at all, which in truth it does. The participants clearly thought the two responses to be relatively inappropriate, with the system's less preferred response consisting of a lesser, wrong implication.

8.4 Discussion

The results of the summative evaluation are very encouraging. On the one hand the fact that real tutors rated the model's responses as not significantly different from the human responses suggests that both the situational model and the method for assigning the Autonomy and Approval values to surface forms are in line with the choices of experienced human tutors. The fact that the same analysis revealed statistically significant differences between (a) human responses and the system's less preferred choices, and (b) the system's preferred and less preferred responses adds strength to the no-difference result between the human and the system's preferred choices. The encouraging results as to the validity of the model are also reinforced by the participants' unsolicited comments during the task with respect to the situational factors reflected in the dialogues. All of the participants agreed that the factors play an important part in the decisions that they tend to make during their normal tutoring activities as to the appropriate ways of responding to students. The participants' comments included remarks with respect to varying amounts of control (Autonomy dimension) that they would give to different students (e.g., one participant commented that he tends to give "more control to students that are confident") and with respect to the directness with which they would criticise the students (Approval dimension) (e.g., the same participant commented on bored students who need a direct approach in order to start working efficiently). Other participants commented on the importance of encouraging the students, especially when the material is difficult and the students lack confidence. All these comments suggest that the tutors were sensitive to the situational factors tested and that their ratings reflected this sensitivity.

Although very positive, the results of the evaluation study need to be accepted with caution. This is because of two factors. First the results rely on limited data – only four tutors took part in the study and only twenty out of the total of 256 situations were tested. This means that the same encouraging results could not be obtained in the "by-subject" analysis which showed no significant differences for any of the three pairs of responses rated. Second, the results may have been affected by the problems related to the correctness of the content of some of the dialogues used in the materials. All of the participating tutors spotted the problems in the content and reported that their judgements of the responses may have been influenced negatively by it. As a consequence of the limited data available, the results cannot be treated as completely robust. Instead they ought to be treated as indications of the way in which various parts of the model perform given the assumptions on which it was built.

Considering the positive results, while taking into account the limitations of this evaluation, it seems that although the model may indeed reflect some of the processes involved in teachers' making linguistic decisions to students' erroneous actions accurately, it is by no means complete or fault free. This is illustrated the best by the "by-eye" analysis of the mean ratings of the three responses for individual dialogues. Based on this analysis, it becomes apparent that while some of the ratings of the system's preferred responses are indeed the same or even better than the ratings of the human responses, there are a number of problematic cases in which the system's preferred responses are regarded as much worse than the human choices and even as worse than the system's less preferred recommendations. This suggests that both the situational model and the method for assigning the Autonomy and Approval values may not be sensitive enough to remedy these problematic aspects. As was discussed earlier, the formative evaluation of the situational component in the form of the summary of the input to the network which is determined by the study of Chapter 5, suggests that the situational component never produces the highest nor the lowest possible Autonomy or Approval values, preventing the surface forms which are coded with such low and high values from being ever selected (there are three such cases in the current case base). On the other hand, the Autonomy and Approval coding scheme may not always be sensitive enough to differentiate between certain otherwise very similar forms. For example, it was suggested that in dialogue 14, the participants' preference for the system's less strongly recommended response over the most recommended one may have been the result of the first one being a less long-winded one than the last. The coding scheme does make one assumption regarding the length of a response in that more words are typically dedicated to giving more Approval to the student. It is possible that the assumption is too simplistic and that it needs to be qualified appropriately to account for the differences between the possible responses on a finer-grained level.

Given that there is no precedent of a similar model being built and hence there is no way in which to compare the performance of the current model to any other system, in the future, the model requires to be validated further with more tutors participating in the evaluation and with the problematic aspects of the materials being remedied. Nevertheless, the results of the current evaluation suggest that the model reflects many of the aspects of the decision processes involved in a teacher or experienced tutor choosing an appropriate response to a student's erroneous action. Specifically, the results throw light on the possible validity of the two main components of the model: the situational and the linguistic component. First, they suggest that the tutors are familiar with the situational factors and that they perceive them as influencing their choices. The tutors comments regarding the individual factors also suggest that the way in which the situational part of the model combines the factors and the way in which these factors are related in the model to the dimensions of Autonomy and Approval respectively is in line with their own interpretations of the way in which those factors function (tutors' unprompted comments). Second, with respect to the linguistic component of the model, the results suggest that, on the whole, the method for assigning Autonomy and Approval values to surface forms reflects human tutors' interpretations of those forms in terms of how appropriate they are in given situations. As a consequence the evaluation suggests that the definitions of Autonomy and Approval dimensions on which the current model is built are also plausible. In conclusion, although a larger scale evaluation involving more tutors and more situations is required to confirm the current results, the current evaluation provides encouraging clues as to the validity of the basis for the model presented in this thesis.

8.5 Summary

In this chapter, the model presented in the current thesis was evaluated. The formative evaluation ensured that the system from which the output was used to evaluate the model reflected the model accurately. A stability test was also used during the formative evaluation to ensure a relative consistency of the method for assigning the Autonomy and Approval values to surface forms.

The summative evaluation involved three types of responses being rated according to their appropriateness in given situations by experienced tutors. The results, which due to limited data need to be treated as preliminary, are very encouraging showing not only that the human tutors relate to many aspects of the model, but crucially that the linguistic behaviour that the model captures is very much in line with that of human tutors.

Chapter 9

Discussion and Conclusions

9.1 Summary of the Research

The current thesis presented a computational model of situationally determined selection of corrective responses to student's erroneous actions. The model is theoretically and empirically motivated. The main focus of the model was placed on capturing the underlying reasons for linguistic variation as caused by the varying degrees of politeness expressed in the language produced by teachers in student-corrective situations. The focus was also placed on identifying a mapping between those underlying factors and the concrete linguistic realisations produced by teachers in the aforesaid situations.

Since, in theoretical linguistics, the varying degrees of politeness have been associated with the varying degrees of linguistic indirectness (e.g., Brown and Levinson (1987); Fetzer (2003)), a thorough examination of educational dialogues presented itself as the obvious first step in determining the exact type of linguistic phenomena for which the model were to account. The analysis of two sets of educational dialogues was conducted, which led to a conclusion that the considerable amount of variation in the corrective responses produced by teachers could be characterised in terms of the different degrees of indirectness. The examination of the linguistic data has also highlighted the need for a definition of linguistic indirectness which would reflect the language used by teachers in educational settings. While in theoretical linguistics, in general terms, indirectness is typically associated with illocutionary specificity (e.g., Grice (1989)), the language produced by teachers seems to be characterised also by the varying degrees of content specificity which, in Chapter 3, was said to contribute to the overall effect of indirectness with which a given message is encoded. Although content specificity has been linked to teachers/tutors responses by other researchers (e.g., Graesser *et al.* (1995); Person *et al.* (1995)) this is the first time that it has been identified as one of the dimensions contributing to the linguistic indirectness.

Following many proposals in linguistics (e.g., Spencer-Oatey (1992)) regarding the important role of context in determining the appropriate way of encoding a message linguistically, the analysis led to an observation that there may be specific situational factors which individually or in specific combinations with other situational factors, can directly influence the form of a linguistic act. In Chapter 4 this observation was examined in more detail based on further dialogues analysis and on educational literature in which some of the most relevant factors to teachers decisions were identified. Eight situational factors were proposed in this thesis to be of special relevance to the decisions that teachers make in student-corrective situations. These factors were proposed as one of the pre-requisites needed for building the model of teachers selecting corrective responses. In Chapter 5 these factors were validated by means of an exploratory study with teachers. The factors were presented to teachers in different combinations and the teachers were asked to rate them according to how much they thought they could affect their linguistic responses. The teachers were also asked to comment on the individual factors in order to justify their ratings and to provide example responses to the given factor-combinations.

The study provided a basis for designing and implementing the situational part of the model. Teachers' ratings were used to identify the correlations between the factors, while the Principle Component Analysis was used to group the factors according to the underlying phenomena that they commonly refer to. Three groups were identified which, for most part, confirmed the expectations stated in Chapter 4 with respect to the possible links between the factors. These three groups were taken as the basis for combining the situational factors in the situational part of the model presented in Chapter 6, where they were used to calculate the values of the two underlying dimensions of student's Face: the Autonomy and the Approval dimensions.

Following the strong claims by many social linguists and ethnomethodologists (e.g., Brown and Levinson (1987), Spencer-Oatey (1992), Fetzer (2003)) as to politeness being the underlying cause of linguistic indirectness and of linguistic variation, the analysis of the two sets of dialogues was conducted with the purpose of identifying the possible reasons for, and the different ways in which teachers vary their language. In line with other research such as that by Person *et al.* (1995) and Fox (1991) the analysis led to a conclusion that teachers encode their messages by indirect forms to prevent the students from getting demotivated, while at the same time to allow them as much freedom of initiative as possible. Face is a socio-cultural and psychological notion identified by Leech (1980) as being central to any socio-culturally acceptable use of language within a given speech community. Following the detailed account of Face by Brown and Levinson (1987), in Chapter 4, it was identified and defined as the second pre-requisite to the model of teachers selecting corrective responses. Because teachers' language seems to be governed by somewhat different socio-cultural norms than those which control normal conversations, Face was defined in terms of two dimensions of Autonomy and Approval to reflect the differences between the normal social conversations and the language produced in the educational circumstances in which student's need to be corrected. To reduce the complexity of the model, contrary to Brown and Levinson's proposal, the definition of Face was limited in the current thesis to refer only to the socio-emotional needs and wants of the student without accounting for the Face oriented needs and wants of the teacher.

The two dimensions of Face were defined in Chapter 4 to suit the educational settings under investigation. Autonomy was said to refer to the student's want for his freedom of initiative to be unimpeded. In that sense, the degree to which a teacher was said to be able to vary the Autonomy given to a student was linked directly to the varying degrees of content specificity as identified in the corrective responses found in the dialogues. On the other hand, Approval was defined in Chapter 4 as a dimension of a student's Face which refers to his need to be approved of by having his confidence and interest maintained. In the corrective situations, Approval corresponds directly to the illocutionary specificity, in that the teachers' message as to the student being incorrect may have to be underspecified if a given student's need for approval is great.

Face is acknowledged and accounted for through language differently in different speech communities. To inform and to guide its members as to the acceptable social and linguistic behaviour, a given community establishes and maintains specific conventions. These conventions are expressed in the communicative strategies which tend to guide speakers as to the ways in which to avoid threat to their interlocutors' Face and how to avoid a possible break down in communication. In education, the notion of strategy can be also understood as a form of convention which aims at promoting and at maintaining students' progress. Typically, educational strategies are concerned with structuring the process of students' knowledge acquisition. In Chapter 4 both types of strategies were said to be compatible with one another and with the notion of Face as defined in terms of Autonomy and Approval. The notion of strategy was identified as the third pre-requisite to the model of teachers selecting corrective responses and in Chapter 4 the characteristics of a communicative strategy in the educational context in question were stated.

In Chapter 6 the two dimensions of Face were said to constitute the link between a situation and the possible linguistic responses to the situation. Based in part on the results of the study with teachers, presented in Chapter 5, the situational part of the model was therefore designed to infer the Autonomy and Approval values. The situational factors were said to cluster around three underlying dimensions related to both temporal and material oriented aspects of the lesson, to the student's performance and to his motivation respectively. Detailed rules in which these different factors may combine were proposed, which rules were used in the implementation of the situational part of the model (Chapter 7) to populate the different nodes in the Bayesian Network.

In the linguistic part of the model, surface forms were classified in terms of the communicative strategies employed by teachers in the corrective situations according to the different values of Autonomy and Approval. The different strategies were identified based on the educational literature as well as on the dialogues analysis, and they were classified according to their intentional properties and the type of language to which they tend to lead. A strategic system was presented in Chapter 6 in which the strategies were split between the main and the auxiliary ones to reflect the fact that the first type leads to the surface encodings of the main messages, while the latter tends to lead to "additional language" aimed primarily at rectifying the potential threat expressed by the main message.

In the implementation of the model presented in Chapter 7, a set of surface forms coded for Autonomy and Approval values were stored in a case base from which they were retrieved based on the information computed by the Bayesian Network used to represent the situational part of the model.

The evaluation of the system and the model led to very encouraging, albeit still requiring further confirmation, results with respect to the validity of the approach. In the final evaluation study, expert human tutors were asked to compare three types of responses and to rate them according to how appropriate they were for the situations encapsulated in the dialogues provided to them. The responses included one produced by a human, one recommended by the system, and one response that the system was less likely to recommend. The results of the study suggest that while the tutors perceive the human and the system's less preferred responses as different, there was no significant difference in their ratings of the responses produced by the human and those most strongly recommended by the system.

9.2 Critical Remarks

Although the results of the final evaluation are very encouraging with respect to the validity of the model, it is essential to treat them as informative only on the preliminary level. The model presented in this thesis is a prototype without a precedent against which it could be compared. Given that it is a prototype, the model often combines the theoretical contributions by other researchers in a somewhat simplified and even naive manner which leaves it open to a considerable amount of criticism. Furthermore given the breadth of the theoretical and empirical basis for the model, the research presented in this thesis may be again the subject of scrutiny by those who prefer a narrower research scope. In the remainder of this section some of the possible critical comments regarding the various aspects of the model, its basis, its implementation and evaluation are presented and addressed.

Is it valid to treat the linguistic evidence from tutorial and classroom dialogues on a par with each other? Many designers of tutoring systems as well as educational psychologists could, and almost certainly would, object to the fact that in the current thesis the linguistic evidence on which the model is built derives from two types of educational exchanges proclaimed by many as distinct from one another. The tutorial exchanges are typically understood to be carried out on a one-to-one basis, while the classroom teaching happens between one teacher and many pupils. On the language structural level, in Chapter 2 the main differences between the two types of exchanges were presented as referring mainly to the lack of certain tutoring steps under the classroom conditions, which steps are regarded as essential (e.g., Graesser *et al.* (1995)) to promoting students' deep and individualised learning. Several advantages of one-to-one teaching were identified, including the fact that typically a tutor can individualise their methods according to the cognitive and emotional needs of the student, she can spend more time addressing a particular topic and can provide the student with more indepth feedback (e.g., Lepper and Chabay (1988); Lepper *et al.* (1993); Graesser *et al.* (1995)). It is not the intention of this thesis to argue with these claims as it seems common sense that the fewer the students, the more personalised form of teaching and communication can be offered. However, the comparison of the two types of dialogues with respect to the corrective responses produced by the tutor in the Pittsburgh dialogues and the teachers in the Polish exchanges, revealed no major differences in terms of the types and the linguistic realisations of the responses used. It is true that the Polish teachers spent less time addressing the same student, but the strategies used to correct the students, including the further steps claimed by Graesser *et al.* (1995) to be absent under classroom conditions, and the types of syntactic constructions employed by teachers differed little from those used by the tutor in the one-to-one exchanges.

This is one of the main reasons for the distinction between teachers and tutors being blurred in the current approach.

Are the definitions of situational context and Face sufficiently representative of real life phenomena? As was stated at many points in this thesis, the model presented here represents a simplified version of the theoretical and empirical evidence provided by researchers such as Brown and Levinson (1987). With respect to the situational model, an objection could be raised as to its completeness and further as to the validity of representing the individual situational factors in terms of binary rather than continuous values. The number of the situational factors used in the model was motivated largely by the educational literature in which several other factors were proposed. In particular, the literature concerned with examining the aspects of tutorials which motivate students suggests additional factors such as the student's satisfaction, the freedom with which the student can exercise his sense of fantasy during a lesson, etc. By no means does the current situational model claim completeness in terms of the factors modelled. Instead, it claims that the factors included represent those factors which are most commonly referred to in the literature and which were further validated by the situational study with teachers. Certainly, in the future the model could be extended by further situational factors. With respect to the values that the situational factors are allowed to assume in the current model, one could criticise the model to be implausible. Certainly, it is not the claim of this thesis, that such extreme values characterise real situations. Again, the factors used in the current model represent a simplified version of the real world. Surprisingly, even with those limitations the model manages to account for linguistic variation well. In the future this aspect of the model could also be extended.

The main objections with respect to the definition of Face may refer to the rejection of Brown and Levinson's social variables of Power and Distance as well as to Face being associated only with the students' needs and wants. In Chapter 2 an extensive discussion of the problematic aspects of Brown and Levinson's approach was provided and the unconfirmed role and the interaction of the two social variables was highlighted through review of other researchers experiments. Furthermore, with respect to the distance variable, the situational study with teachers suggested that it does not play a major part in affecting their choices of corrective responses. However the nature and the possible role of the two variables need to be investigated in detail and specifically to the current model, it needs to be investigated in the context of corrective responses.

An obvious and fair criticism from the point of view of the theory of linguistic politeness would be the objection to Face being defined as representing only the needs and wants of one of the interlocutors in an exchange – in this case the student. As Person *et al.* (1995) observed in her analysis of tutorial dialogues, tutors' responses are often affected by their own needs to be approved of and liked, for instance. The purpose of the current model is not to disconfirm this observation, nor it is to say that a model which attempts to account for the real life phenomena should not account for the facework associated with the teacher's Face. However, it is the claim of the current thesis that to model the aspects of the tutorial interactions which are only associated with the student's Face may be sufficient to capture the variation in the tutor's corrective responses on a preliminary level. This claim seems to be supported by the results of the final evaluation study.

Does the situational study with teachers constitute a valid empirical basis for the model? The study, specifically its design, could be criticised for several reasons. First, it could be criticised for being too difficult for the participants to give sensible answers. Indeed the teachers who participated in the study did comment on how difficult they found the task of remembering and reasoning about the situational factors in different combinations. They also commented on how cumbersome it was to write the comments about each factor and provide real linguistic responses to dry situation descriptions. It is true that to respond in a sensible manner a considerable effort was required from the teachers. However, the results of the study show that teachers were consistent both within themselves and between each other as to their comments and most importantly as to their ratings. A more serious criticism that could be made with respect to the design of the study is that it was unbalanced. In particular, it could be said that the consistency of the results was influenced by the way in which the situations were lexicalised and the fact that there was very little variation in the order in which the situational factors were presented in each situation. Unfortunately, only another, more balanced study could provide support, or could refute this particular objection. However, the fact that the results of the final evaluation of the model were very positive with respect to the model's recommendations lends support as to the validity of using the situational study as a basis for designing the situational part of the model.

The design of the model is arbitrary to a large extent. Although many design decisions used to develop the current model were based on theoretical and empirical evidence, there are a number of decisions that were made largely on an intuitive basis. The two main aspects of the model which may find themselves under considerable attack from other researchers are the rules for combining the factors, and the method for assigning the Autonomy and Approval values to surface forms. Both of these were presented in Chapter 6. While the method for coding surface forms for Autonomy and Approval was evaluated with good results both formally and summatively, the fact that there is little theoretical or empirical evidence for the way in which different situational factors may combine (and the evidence that is available in the form of brief mentions and speculations is largely circumstantial) is more difficult to defend. The task of combining the factors to calculate plausible Autonomy and Approval values was made even more difficult by the fact that there is no precedent of a similar situational model being used in the area of Natural Language Generation or in AI in Education. Certainly, if the model is to be used in the future it seems imperative to provide it with a more solid basis than a single designer's intuitions. However, just as is the case with the coding method, both the formative and the final evaluation provide strong support in favour of the design decisions in question.

Is the use of Bayesian Networks method fully justified here? In Chapter 7 the implementation of the situational part of the model was said to rely on two AI techniques: the Bayesian Networks and the Case Based Reasoning. On a general level, the use of the Bayesian Networks was justified in that chapter. However, the case base reasoner had to be used in the implementation to pre-process the evidence to the network, because none of the Bayesian Network packages tried for this model could handle the number of connections between certain nodes in the network and the resulting probability tables. This means that from the implementation point of view, the model is exposed to the criticism that the full potential of Bayesian Networks is not used in this approach. In particular the fact that at present the input to the network is fully specified can be used as a way of dismissing the justification for using this method. There is no doubt that this is an aspect of the implementation that could do with improving to allow for situations in which a teacher is simply not sure what is the value of a given situational factor.

Why not use traditional NLG techniques? Since the model presented in this thesis was designed with the long-term view of generating teachers' corrective responses, a fair question would be to ask why its design and implementation does not rely on some of the more traditional approaches to Natural Language Generation such as planning techniques (e.g., Cawsey (1991); Moore and Paris (1993)) or on systemic-functional grammars (e.g., Bateman *et al*. (1992); Bateman (1997)). Although, the current approach shares many of the assumptions with those approaches, in particular the assumption that speakers produce language as a way of acting upon their intentions and as a way of affecting the mental states of their interlocutors, the current model also embraces the interpretation of language in terms of non-discrete functional categories in which a single linguistic act may be used to encode several different intentions and may belong to more than one category. This view is particularly prominent within the research on speech acts (e.g., Givón (1989)) and more recent approaches to linguistic politeness (e.g., Fetzer (2003)). The approaches to plan-based language generation are based largely on earlier work by Cohen and Perrault (1979) on planning with speech acts and which work relies on the assumptions of the traditional theories of speech acts proposed by Austin (1962) and Searle (1969), for example. In these traditional theories, speech act categories are characterised in terms of single intentions and effects such as INFORM, REQUEST and QUESTION. Consequently the planning operators which are used to inform the linguistic choices are also discrete in nature. Similarly the approaches based on systemic-functional grammars refer to discrete functional categories and as a consequence they do not present themselves as ideal for representing a model such as the current one in which most of the linguistic acts perform several communicative functions simultaneously. However, the fact that the applicability of the traditional approaches was not immediately obvious does not mean that they could not be adapted to accommodate for the model presented here. Indeed, the first attempt to integrate the model presented in this thesis with a dialogue planner and a dynamic language generator is already made as is indicated in section 9.3.

9.3 Further Work

The model presented in the current thesis is intended as the first step towards formalising the theories of linguistic politeness for the purpose of generating an aspect of teachers' language. As such it is only natural to expect it to lack in certain respects and to present opportunities for further improvements and extensions. Some of the possible improvements are relatively small, while others need to be done on a larger scale. The following list, which is by no means exhaustive, presents six of the possible extensions to the current model:

1. **Performing further evaluation studies.** The evaluation of the model discussed in Chapter 8 is very encouraging and it suggests a possible validity of the approach taken in this thesis. However, owing primarily to small number of participants, the significance of the results needs to be verified by further, indepth studies involving more tutors and testing the behaviour of the model in more situations. The evaluation method employed here is essentially sound, but in the further studies, it could rely on more explicit and more extensive "switching off" of various features of the model. More of the system's responses to given situations could be tested and the levels to which these responses are recommended could be more varied than is the case in the study presented in Chapter 8. Moreover, to gain a better view on the appropriateness of the responses produced by the human tutor, different tutors' responses could be compared with each other. The situational component of the model could be tested in a more indepth manner by comparing its current behaviour with a behaviour of a model in which

salience is “switched off” completely or partially.

2. **Extending the model by further situational factors.** The situational part of the model currently operates on the basis of eight situational factors. As was discussed earlier, the list of factors used is not exhaustive in that other aspects of educational situations may be relevant to teachers’ decisions. For example, aspects proposed primarily within the motivational literature, such as student’s satisfaction could be included in the model. The new factors would have to be examined with respect to how they interact with other situational factors based on empirical tests with real teachers.

3. **Extending the situational factors by continuous values.** One of the main limitations of the situational part of the model, especially if it is examined from the point of view of its applicability to tutorial dialogue systems, is the fact that at present the situational factors can only be characterised in terms of binary, extreme values. This means that in a dialogue context this could cause unnaturally abrupt changes in tutor’s style of responses, if for example the factor STUDENT’S CONFIDENCE were flipped from *not confident* to *confident* or TIME LEFT were flipped from *plenty* to *very little* over the course of, say, two moves.

4. **Extending the definitions of Face.** A more complex extension, but theoretically strongly motivated is the inclusion of the teacher’s Face in the model. At present only student has Face which is theoretically false, and would be interesting to see what effects the inclusion of the teacher’s wants and needs may have on her linguistic choices. However, it is also important to bear in mind the results of the linguistic analyses such as that by Person *et al.* (1995) in which the facework associated with the tutor’s self-image was shown to have sometimes a negative effect on the students’ successful learning. Thus, a question which ought to constitute part of investigating this particular extension to the model, is whether a tutorial dialogue model should be generally more natural and therefore educationally imperfect, or whether it ought account only for the aspects of teachers’ language which are fully beneficial to students’ progress, and where simply there may not be a place for a teacher’s Face.

5. **Testing for P and D in educational circumstances.** In Chapter 2 an extensive discussion was presented regarding the non-linear and often counter-intuitive relationship between Brown and Levinson's variables of Power and Distance and the language produced. In Chapter 4 it was argued that these variables do not play the same and prominent role in teachers language as they do in normal conversations. Some of the results of the study lent a certain amount of support to the decision to eliminate the D variable from the current model. However, given the complexity of the way in which the two variables were shown by other researchers to behave, it would be desirable to test them specifically in the context of educational exchanges and with respect to corrective responses.

6. **Extending the model to other types of responses made by teachers.** The current model is designed to account only for the corrective responses that teachers make. However, if the model is to be useful in the context of tutorial dialogue systems, it needs to be able to account for other forms of responses such as explanations, acceptances of students' actions etc. This would also allow one to gain a wider understanding of the model's applicability to dialogue systems, and as to the validity of its assumptions in a wider linguistic context.

7. **Integration with dialogue systems.** A major extension to the current model would involve it being integrated with a real tutorial dialogue system. Most of the extensions proposed thus far would contribute to preparing the model for such an integration. However, other extensions would have to be made to facilitate a smooth functioning of the model within a dialogue system. One of them would have to involve a method for detecting the relevant information from other components of the dialogue system. This information would be used to determine the appropriate situational factor-values for every move in the dialogue. Finding an appropriate detection method is not trivial. For example, what information and in what quantities should contribute to the situational factor STUDENT'S INTEREST to be set to *bored*, and at what point should the system assume that there is *very little* time left till the end of the session? Some current work on student's motivation detection could be used to aid the determination of certain factor-values (de Vicente, 2003), but the methods for inferring the

values for other factors would have to be established empirically. Another issue which would have to be addressed if the model were to be integrated with a dialogue system would involve it being used in the context of the traditional NLG techniques such as planning. For example in a dialogue system based on planning, the current model would have to be split into the situational modeller which would contribute information to the planner (the Autonomy and Approval could be used to choose operators), and the linguistic component would have to be integrated with the entire planning mechanism. For example, while the current implementation of the model does not make use of the linguistic strategies explicitly, in a dialogue system the strategies could be included in the operators along with the ranges of the Autonomy and Approval values that correspond to them. These, along with additional information from other parts of the system such as the domain knowledge base as well as the previous answer given by the system, could be used further to narrow the search for the appropriate surface and lexical form. First steps have been taken already to integrate the current model with the BEETLE tutorial dialogue system Zinn *et al.* (2003).

9.4 Conclusions

The purpose of the research presented in this thesis was to investigate and to model linguistic variation as caused by speakers varying the degrees of politeness with which they attempt to achieve their communicative goals. The focus was specifically on teachers language as produced in situations in which students need to be corrected. The model of linguistic politeness presented here in the context of education, relies both on theoretical and empirical evidence. On the one hand, the theories of linguistic politeness such as that by Brown and Levinson (1987) were used as the basis for the model. The theories had to be adapted to suit the educational context and to account for the fact that teachers' language is governed by somewhat different norms and conventions from those which dictate socially acceptable encodings of potentially Face threatening messages in normal conversations. On the other hand, empirical evidence was used in the form of the dialogues analysis and the situational study with teachers to fuel the design and the implementation of the model. Whether it can be extended easily, and whether it can function well as a whole, or in part, when part of a proper dialogue system, remains to be seen. All in all, despite its various obvious limitations and simplified assumptions on which it is based, the model fares well as compared with human performance and it does present itself as good first step towards more natural, situationally and user-sensitive, socially intelligent language generation in educational contexts.

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Appendix A

Example of a completed teacher questionnaire

Your name: **CM**

For how many years have you been teaching? **16**

What subject(s) have you taught? **Programming, Dialogue, Syntax**

What age group have you taught (e.g. primary, secondary, university)? **Postgraduate**

Thank you for agreeing to participate in this study. This questionnaire has been designed to elicit information about how different aspects of educational situations affect teachers' linguistic choices. The questionnaire should take approximately 1/2 hour to complete.

Background

When we speak to students, we may say the same thing in many different ways, depending on the student in the particular situation. In this study we are interested in understanding better how we choose between different ways of saying the same thing and what in particular about the situation influences our choices the most.

Your Task

We will present you with 5 different situations. In each case we would like you to think about what exactly influences the manner or style of your response in this situation. For example, imagine that the student has made an error. Depending on the exact situation you may address it in different ways such as *"X is wrong"*, *"Could it be Y?"*, *"Do you really think it's X"*, *"It could be X, but..."*, etc.

1. We would like you to make some notes on what aspects of the situation would influence you most in this particular case. (You may wish to include examples of possible responses). Use the blank page provided below each situation description to note your thoughts.

2. We have listed several aspects that may (or may not) be important, and we would like you to indicate for each how much you feel it would influence you in this particular situation.

Begin

For each situation description, imagine that you are teaching a subject that requires a student to learn *how* to do something as opposed to merely memorising facts. Possible domains may include electric circuitry, maths or principles of cooking. The subject should consist of many related topics, which may have to be taught over several lessons. The lesson is on a one-to-one basis.

Situation 1.

You have several topics left to cover in the current lesson and you have plenty of time left at your disposal. The topics are not crucial, but are useful to student's overall understanding of the subject. The topics are relatively easy. The student that you are dealing with is confident and has a good sense of humour. He seems interested in the lesson. His overall progress is slow and his latest answer is incorrect. Your rapport with the student is an informal one.

Your notes on what aspects of the situation you feel would influence you most in this particular case. (You may wish to include examples of possible responses).

The main things I'd worry about are that the topics are easy, the student is concentrating, and not nervous, but the answer is wrong. That suggests that the guy isn't too bright, and I'd be inclined to make my language as plain as possible, and my sentences as short as possible, to try to get to the root of the misunderstanding.

So something simple like:

"why did you say that BLAH is BLAH"

and so on. And I'd tend to keep going with similar short, basic questions and pieces of info to try to make sure that something gets across, ideally hinting at the right answer rather than saying it outright.

For each aspect listed below, please indicate how much you feel it would influence you in this particular situation. Use the scale provided below, to indicate the importance of an aspect to your decisions.

1. *Number of topics still to be taught*

   Not Important 1 2 *** 3 *** 4 5 Very Important

2. *Importance of the topics still to be taught*

   Not Important 1 *** 2 *** 3 4 5 Very Important

3. *Difficulty of the topics still to be taught*

   Not Important 1 *** 2 *** 3 4 5 Very Important

4. *Time left to the end of the tutorial*

   Not Important 1 *** 2 *** 3 4 5 Very Important

5. *Student's aptitude*

   Not Important 1 2 3 4 *** 5 *** Very Important

6. *Student's apparent interest in the tutorial*

   Not Important 1 2 3 *** 4 *** 5 Very Important

7. *The degree of formality of the relationship between you and your student*

   Not Important *** 1 *** 2 3 4 5 Very Important

8. *Student's sense of humour*

   Not Important 1 *** 2 *** 3 4 5 Very Important

9. *Student's confidence level*

   Not Important 1 2 3 *** 4 *** 5 Very Important

10. *Correctness of student's latest answer*

    Not Important 1 2 3 4 *** 5 *** Very Important

Situation 2.

You have several topics left to cover in the current lesson and you have very little time left at your disposal. The topics are crucial to student's overall understanding of the subject, but they are relatively easy. The student that you are dealing with is not confident, but has a good sense of humour. He seems bored with the lesson. His overall progress is slow and his latest answer is incorrect. Your rapport with the student is an informal one.

Your notes on what aspects of the situation you feel would influence you most in this particular case. (You may wish to include examples of possible responses).

The main things here are the importance of the main topics and the lack of time. The only option I can see is to get the student to look at the material himself, and so the problem is to highlight the importance of the material and to engage interest. Because of the wrong answer, and the easy topic, I'd try to make my language as simple as possible, but I'd be writing longer sentences, almost lecturing but almost certainly pormpting for understanding acts:

"we need to add water, ok? - so..."

"a light bulb is a load, right?"

Getting the student's interest is very important, and it's possible that an attempt at humour, if appropriate, might help.

For each aspect listed below, please indicate how much you feel it would influence you in this particular situation. Use the scale provided below, to indicate the importance of an aspect to your decisions.

1. *Number of topics still to be taught*

   Not Important 1 2 3 *** 4 *** 5 Very Important

2. *Importance of the topics still to be taught*

   Not Important 1 2 3 *** 4 *** 5 Very Important

3. *Difficulty of the topics still to be taught*

   Not Important 1 2 *** 3 *** 4 5 Very Important

4. *Time left to the end of the tutorial*

   Not Important 1 2 3 *** 4 *** 5 Very Important

5. *Student's aptitude*

   Not Important 1 2 3 *** 4 *** 5 Very Important

6. *Student's apparent interest in the tutorial*

   Not Important 1 2 3 *** 4 *** 5 Very Important

7. *The degree of formality of the relationship between you and your student*

   Not Important 1 *** 2 *** 3 4 5 Very Important

8. *Student's sense of humour*

   Not Important 1 2 *** 3 *** 4 5 Very Important

9. *Student's confidence level*

   Not Important 1 2 *** 3 *** 4 5 Very Important

10. *Correctness of student's latest answer*

    Not Important 1 2 3 *** 4 *** 5 Very Important

Situation 3.

You have one topic left to cover in the current lesson and you have very little time left at your disposal. The topic is not crucial, but it is useful to student's overall understanding of the subject. The topic is also relatively easy. The student that you are dealing with is not confident and has no sense of humour. He seems bored with the lesson. His overall progress is slow and his latest answer is incorrect. Your rapport with the student is a formal one.

Your notes on what aspects of the situation you feel would influence you most in this particular case. (You may wish to include examples of possible responses).

This is tricky - I'd be inclined to forget about the topic! I never have 'formal' relationships with students, I don't think, so it's hard to imagine this. As with any other student who's having trouble understanding something simple, my language would be as plain as possible, and I think I'd use a similar strategy to the previous one - just lecturing, effectively, but checking understanding (and attempting to evaluate the responses).

Getting interest will be difficult with no humour, in my experience - I'd probably try to engage the student through some other interest (if I know of any).

For each aspect listed below, please indicate how much you feel it would influence you in this particular situation. Use the scale provided below, to indicate the importance of an aspect to your decisions.

1. *Number of topics still to be taught*

Not Important	1	*** 2 ***	3	4	5	Very Important

2. *Importance of the topics still to be taught*

Not Important	1	2	3	*** 4 ***	5	Very Important

3. *Difficulty of the topics still to be taught*

Not Important	1	2	*** 3 ***	4	5	Very Important

4. *Time left to the end of the tutorial*

Not Important	1	2	3	*** 4 ***	5	Very Important

5. *Student's aptitude*

Not Important	1	2	3	*** 4 ***	5	Very Important

6. *Student's apparent interest in the tutorial*

Not Important	1	2	*** 3 ***	4	5	Very Important

7. *The degree of formality of the relationship between you and your student*

Not Important	*** 1 ***	2	3	4	5	Very Important

8. *Student's sense of humour*

Not Important	1	2	*** 3 ***	4	5	Very Important

9. *Student's confidence level*

Not Important	1	2	3	*** 4 ***	5	Very Important

10. *Correctness of student's latest answer*

Not Important	1	2	3	*** 4 ***	5	Very Important

Situation 4.

You have one topic left to cover in the current lesson and you have plenty of time left at your disposal. The topic is not crucial, but is useful to student's overall understanding of the subject. The topic is relatively difficult. The student that you are dealing with is confident and has a good sense of humour. He seems interested in the lesson. His overall progress is slow and his latest answer is only partially correct. Your rapport with the student is a formal one.

Your notes on what aspects of the situation you feel would influence you most in this particular case. (You may wish to include examples of possible responses).

In this case I'd try to make the interaction a dialogue as much as possible - the student is likely to be able to work out a lot of the stuff themsielves, with the occasional piece of information from me. So, unlike the previous situations, I'd be trying to get the student to talk much more. The student's confidence, interest, and sense of humour are the main things that would suggest this approach. To get a dialogue going, I'd be saying something like:

"why did you say that?"

and all the other standards!

For each aspect listed below, please indicate how much you feel it would influence you in <u>this particular</u> situation. Use the scale provided below, to indicate the importance of an aspect to your decisions.

1. *Number of topics still to be taught*

Not Important	1	* 2 *	3	4	5	Very Important

2. *Importance of the topics still to be taught*

Not Important	1	* 2 *	3	4	5	Very Important

3. *Difficulty of the topics still to be taught*

Not Important	1	2	* 3 *	4	5	Very Important

4. *Time left to the end of the tutorial*

Not Important	1	2	* 3 *	4	5	Very Important

5. *Student's aptitude*

Not Important	1	2	* 3 *	4	5	Very Important

6. *Student's apparent interest in the tutorial*

Not Important	1	2	3	* 4 *	5	Very Important

7. *The degree of formality of the relationship between you and your student*

Not Important	* 1 *	2	3	4	5	Very Important

8. *Student's sense of humour*

Not Important	1	2	* 3 *	4	5	Very Important

9. *Student's confidence level*

Not Important	1	2	3	* 4 *	5	Very Important

10. *Correctness of student's latest answer*

Not Important	1	2	* 3 *	4	5	Very Important

Situation 5.

You have one topic left to cover in the current lesson and you have plenty of time left at your disposal. The topic is crucial to student's overall understanding of the subject and it is also relatively difficult. The student that you are dealing with is not confident, but has a good sense of humour. He seems interested in the lesson. His overall progress is fast, but his latest answer is only partially correct. Your rapport with the student is an informal one.

Your notes on what aspects of the situation you feel would influence you most in this particular case. (You may wish to include examples of possible responses).

Because of the importance of the topic and the student's apparent ability, I think I'd be lecturing more (so longer sentences, and probably more technical language). However, where possible it would useful to get a dialogue going to increase the student's confidence.

For each aspect listed below, please indicate how much you feel it would influence you in this particular situation. Use the scale provided below, to indicate the importance of an aspect to your decisions.

1. *Number of topics still to be taught*

   Not Important 1 2 *** 3 *** 4 5 Very Important

2. *Importance of the topics still to be taught*

   Not Important 1 2 3 *** 4 *** 5 Very Important

3. *Diffi culty of the topics still to be taught*

   Not Important 1 2 3 *** 4 *** 5 Very Important

4. *Time left to the end of the tutorial*

   Not Important 1 2 *** 3 *** 4 5 Very Important

5. *Student's aptitude*

   Not Important 1 2 3 *** 4 *** 5 Very Important

6. *Student's apparent interest in the tutorial*

   Not Important 1 2 *** 3 *** 4 5 Very Important

7. *The degree of formality of the relationship between you and your student*

   Not Important *** 1 *** 2 3 4 5 Very Important

8. *Student's sense of humour*

   Not Important 1 *** 2 *** 3 4 5 Very Important

9. *Student's confi dence level*

   Not Important 1 2 3 *** 4 *** 5 Very Important

10. *Correctness of student's latest answer*

   Not Important 1 2 *** 3 *** 4 5 Very Important

Appendix B

Tables for the relative importance of factors overall given the individual factor-values

	Aptitude = high			*Aptitude = low*			*Confi dence = high*			*Confi dence = low*		
Variable	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**
S’ Aptitude	3.92	1.00	60	3.94	1.05	51	4.06	1.00	54	3.81	1.03	57
Time left	3.78	1.06	60	3.61	1.13	51	3.74	.94	54	3.67	1.23	57
Material left	3.05	1.32	60	2.85	1.24	52	2.89	1.19	54	3.02	1.37	58
Diffi culty of material	3.55	1.10	60	3.61	1.00	51	3.69	.99	54	3.47	1.10	57
Importance of material	3.48	1.14	60	3.80	1.02	51	3.91	.90	54	3.37	1.20	57
Correctness of S’ answer	3.42	1.05	60	3.75	1.03	52	3.76	.97	54	3.40	1.09	58
S’ Confi dence	4.15	.82	60	3.85	.87	52	4.00	.85	54	4.02	.87	58
S’ Interest	3.92	.83	60	3.84	.88	51	4.00	.85	54	3.77	.85	57
Additional Factors												
Formality	2.74	1.18	58	2.27	1.20	51	2.55	1.26	53	2.27	1.20	51
S’ sense of Humour	2.80	1.12	60	2.44	1.04	52	2.54	1.19	54	2.44	1.04	52

Table B.1: Relative importance of each factor given the student’s aptitude values high and low respectively

	Correctness = p-correct			*Correctness = incorrect*			*Diffi culty = easy*			*Diffi culty = diffi cult*		
Variable	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**
S' Aptitude	3.87	.95	39	3.96	1.05	72	3.91	1.10	65	3.96	.89	46
Time left	3.90	1.02	39	3.60	1.12	72	3.74	1.06	65	3.65	1.14	46
Material left	3.10	1.39	39	2.88	1.22	73	2.97	1.32	66	2.93	1.24	46
Diffi culty of material	3.59	1.07	39	3.57	1.05	72	3.51	1.11	65	3.67	.97	46
Importance of material	3.69	1.13	39	3.60	1.08	72	3.68	1.11	65	2.93	1.24	46
Correctness of S' answer	3.82	.88	39	3.44	1.11	73	3.73	1.07	66	3.35	.97	46
S' Confi dence	4.10	.85	39	3.96	.86	73	4.06	.78	66	3.93	.95	46
S' Interest	3.82	.79	39	3.92	.88	72	3.86	.95	65	3.91	.95	46
Additional Factors												
Formality	2.78	1.23	37	2.39	1.18	72	2.47	1.19	64	2.60	1.23	45
S' sense of Humour	2.79	1.13	39	2.55	1.07	73	2.62	1.13	66	2.65	1.04	46

Table B.2: Relative importance of each factor given the correctness of student's answer values partially correct and incorrect respectively

	Importance of mat. = no crucial			*Importance of mat. = crucial*			*S' interest = interested*			*S' interest = bored*		
Variable	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**
S' Aptitude	3.89	1.03	62	3.98	1.01	49	3.76	1.09	55	4.09	.92	56
Time left	3.61	1.22	62	3.82	.91	49	3.71	1.13	55	3.70	1.06	56
Material left	2.84	1.35	63	3.10	1.19	49	3.11	1.31	55	2.81	1.25	57
Diffi culty of material	3.42	1.19	62	3.78	.80	49	3.65	1.04	55	3.50	1.06	56
Importance of material	3.35	1.20	62	3.98	.83	49	3.73	1.06	55	3.54	1.13	56
Correctness of S' answer	3.44	1.12	63	3.73	.93	49	3.76	.98	55	3.39	1.08	57
S' Confi dence	4.02	.91	63	4.00	.79	49	4.11	.88	55	3.91	.83	57
S' Interest	3.87	.78	62	3.90	.94	49	3.95	.76	55	3.82	.94	56
Additional Factors												
Formality	2.46	1.30	61	2.60	1.09	48	2.57	1.25	54	2.47	1.17	55
S' sense of Humour	2.68	1.12	39	2.57	1.06	49	2.75	1.14	55	2.53	1.04	57

Table B.3: Relative importance of each factor given the importance of material values partially correct and incorrect respectively

	Material left = little			*Material left = a lot*			*Time left = plenty*			*Time left = very little*		
Variable	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**	**Mean**	**Std Dev**	**Cases**
S' Aptitude	3.78	1.07	65	4.13	.91	46	3.78	1.01	55	4.07	1.01	56
Time left	3.80	1.11	65	3.57	1.07	46	3.45	1.09	55	3.95	1.05	56
Material left	3.02	1.25	66	2.87	1.34	46	2.84	1.23	55	3.07	1.33	57
Difficulty of material	3.66	1.08	65	3.46	1.00	46	3.42	1.10	55	3.73	.98	56
Importance of material	3.69	1.10	65	3.54	1.09	46	3.36	1.06	55	3.89	1.07	56
Correctness of S' answer	3.44	1.12	66	3.76	.90	46	3.49	1.09	55	3.65	1.01	57
S' Confidence	3.91	.92	66	4.15	.73	46	3.98	.83	55	4.04	.89	57
S' Interest	3.89	.89	65	3.87	.81	46	3.95	.80	55	3.82	.90	56
Additional Factors												
Formality	2.44	1.27	66	2.65	1.11	43	2.58	1.26	55	2.46	1.16	54
S' sense of Humour	2.61	1.11	66	2.67	1.08	46	2.75	1.08	55	2.53	1.10	57

Table B.4: Relative importance of each factor given the amount of material left values partially correct and incorrect respectively

Appendix C

Example of an evaluation questionnaire

THANK YOU FOR PARTICIPATING IN THIS STUDY.

The purpose of the study is to test for the most appropriate ways of reacting to various educational situations in which the students are either completely incorrect or only partially correct. Although the domain is basic electricity and electronics, the emphasis of the study is on the *style* rather than the content of teacher responses.

Your task:

You will be presented with five different dialogues between a teacher and 5 different students. The interactions are adapted from transcripts of real tutorials in basic electricity and electronics. Originally the dialogues were between many different students and one not very experienced tutor, and therefore they may not always correspond to your expectations of good tutorial interactions in the basic electricity and electronics domain. However, you are asked to try to ignore the problematic aspects as much as possible and try to judge the appropriateness of the responses to the dialogue contexts accordingly.

Note that some of the dialogues may seem the same, but all of them do vary (quite subtly in some cases).

After reading each dialogue you will be presented with 3 possible teacher responses. You will be asked to rate each response according to how appropriate it is for the given situation. To this end you will be provided with a scale from 1 to 5 on which to rate the appropriateness of each response. Beware that while some responses may appear relatively suitable, other ones may not be suitable at all and sometimes they may be even non-sensical. You are asked to judge *all* responses even if you find them to be of the latter type.

Dialogue 1 (D.2.1)

(5)

Teacher: What you just said wasn't quite right, but I understand it may not be too obvious at first. Although we're running out of time, it's very important that you understand this bit before we finish for today.

Teacher: We know that there is a relationship between voltage, current and resistance. It is not as you said resitance times voltage = current. Can you guess what it is instead?

Student *(not confi dent)*: Ehmm... the voltage times the current gives you the resistance? (INCORRECT: the correct answer is E=I*R. The student has the correct formula in front of him).

<u>CHOICE 1</u>**Teacher:** Are you sure about that? Why don't you use the formula in front of you?

Not appropriate	1	2	3	4	5	V. appropriate

<u>CHOICE 2</u> **Teacher:** The correct relationship is witten down (E = IR). The equation says that the voltage (on the left) will increase if the current goes up, or, alternatively, will increase if the resistance goes ...

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** But isn't the relationship we looking for in front of you?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 2 (D.3.1)

(7)

Teacher: You're doing really well so far and you seem quite confident with the lab, but you must focus for a little bit longer as this bit is important for future labs and it's not very obvious.

Teacher: What do you know about what the resistance has to be from the relationship between voltage and current?

Student *(bored)*: 2500. (CORRECT)

Teacher: OK, the resistor you want could be 2500 ohms. What would happen if the resistance was less than this? Don't rush – we still have a bit of time left.

Student *(confident)*: You would generate less current. (INCORRECT: *more current would be generated*)

CHOICE 1 **Teacher:** No, it wouldn't generate less current. Try again.

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** Ok, that shows you know the formula, but you should think more carefully about the effects that the formula predicts.

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** Well, you've done the calculation correctly. So you know the formula expressing the relationship between resistance, voltage and current. Let's see if the formula predicts the effect you've suggested.

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 3 (D.5.1)

(15)

Teacher: OK, so the friction opposes the force – if there was enough friction it would prevent the box from moving or it would slow the box down. In either case, could you say that, in a way, the friction was "using up" the force you excerted?

Student: yes.

Teacher *(running out of time)*: Good. That's what's happening to voltage in a light-bulb. It is being "used up". And that creates a complementary difference in charge. It is important to know this for future labs.

Teacher: You're doing great and we managed to cover a lot of material.

Teacher: OK, so now that you know what's happening to voltage in a light bulb, it shouldn't be too difficult for you to tell me what are the two conditions under which you get a difference in charge?

Student *(confi dent, but obviously bored)*: Under the condition that friction is present. (PARTLY CORRECT: the student gave one condition. The desired answer is : if the voltage is either created or used up.)

CHOICE 1 **Teacher:** How would you get the difference in charge? If the voltage is created? If it is used up? Or both?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** Fine. But there is an even more obvious condition giving rise to a difference in charge. What would you say was the most important or significant component in the circuit?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** Why do you think so?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 4 (D.4.1)

(11)

Teacher: You're doing really well, we still need to clarify a few simple things which are nevertheless important.

Teacher: Since we're running out of time, can you briefly explain how to observe polarity?

Student *(interested)*: Yes, that's just making sure the positive wire is connected to the positive side and vice versa (CORRECT)

Teacher: OK, then, if the red lead were connected to the tab number 3 and the black lead to number 4, which tab positions would be included in the negative side of the circuit?

Student *(confident)*: the number 4 tab, of course. (PARTIALLY CORRECT: *the negative side of the circuit would span from tab 3 to 6*

CHOICE 1 **Teacher:** You are right that tab 4 would be on the negative side of the circuit, but is it the only one?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** What gives you the idea that tab 4 is on the negative side of the circuit?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** That's true. Are there any other tabs in the negative side of the circuit?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 5 (D.1.1)

(1)

Teacher: It's very important that you understand this before we move on with the lesson. There's no rush, so take your time now especially that this bit may not be immediately obvious.

Teacher: Do you know what the value of the resistor you are looking for?

Student: No.

Teacher: OK, that's what you need to figure out first. Let us think about this step by step. What do we know about the relationship between resistance, current and voltage?

Student: Is it that the resistance times the voltage gives you the current ? (INCORRECT: the correct answer is E= I*R, i.e. voltage = current times resistance).

CHOICE 1 **Teacher:** Well, suppose that ER= I were the case. Let's fix the voltage E. What would happen if we increased the resistance? What would be the effect on the current?

Not appropriate	1	2	3	4	5	V. Appropriate

CHOICE 2 **Teacher:** Well, we said earlier that the formula is voltage equals what?

Not appropriate	1	2	3	4	5	V. Appropriate

CHOICE 3 **Teacher:** Well, what exactly wouldn't work in the formula you just given?

Not appropriate	1	2	3	4	5	V. Appropriate

Dialogue 1 (D.3.2)

(19)

Teacher: You're doing really well so far and you seem quite confident with the lab, but you must focus for a little bit longer as this bit is important for future labs and it's not very easy. I'll help you out, to speed up a bit, because we still have a few things to cover.

Teacher: What do you know about what the resistance has to be from the relationship between voltage and current?

Student *(bored)*: 2500. (CORRECT)

Teacher: OK, the resistor you want could be 2500 ohms. What would happen if the resistance was less than this? Don't rush – we still have a little bit of time left.

Student *(confident)*: You would generate less current. (INCORRECT: *more current would be generated*)

CHOICE 1 **Teacher:** Ok, think about the resistance being *less* than 2500 ohms. How would this affect the opposition that it gave?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** No, less resitance means less oposition. Try again.

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** Well, if the resistance was less than 2500 ohms then it would surely offer less opposition – less resistance – to current flow. Surely that would mean more current, wouldn’t it?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 2 (D.4.2)

(12)

Teacher: You're doing really well, we still need to clarify a few simple things which are nevertheless important.

Teacher: Since we're running out of time, can you briefly explain how to observe polarity?

Student *(interested)*: Yes, that's just making sure the positive wire is connected to the positive side and vice versa. (CORRECT)

Teacher: OK, then, something more difficult: if the red lead were connected to the tab number 3 and the black lead to number 4, which tab positions would be included in the negative side of the circuit?

Student *(confident)*: the number 4 tab, of course. (PARTIALLY CORRECT: *the negative side of the circuit would span from tab 3 to 6*)

CHOICE 1 **Teacher:** Of course, and all the tabs between ... ?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** Let us try again. Say the black lead is connected to tab 4. Which tab positions would be included in the positive side of the circuit?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** Can you tell me whether tab 4 is the only tab included in the negative side? Would other tabs be included? Would they be to the right of tab 4? To the left of tab 4? In the middle? Or somewhere else?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 3 (D.5.2)

(16)

Teacher: OK, so the friction opposes the force – if there was enough friction it would prevent the box from moving or it would slow the box down. In either case, could you say that, in a way, the friction was "using up" the force you excerted?

Student: yes. (INCORRECT)

Teacher *(running out of time)*: OK, since you seem to be getting confused and we still have lots to cover, I'll tell you: the voltage is being "used up" in the light bulb. And that creates a complementary difference in charge. It is important to know this for future labs.

Teacher: OK, so now that you know what's happening to voltage in a light bulb, it shouldn't be too difficult for you to tell me what are the two conditions under which you get a difference in charge?

Student *(confi dent, but bored)*: Under the condition that friction is present. (PARTLY CORRECT: the student gave one condition. The desired answer is : if the voltage is either created or used up.)

<u>CHOICE 1</u> **Teacher:** OK, that's the used up part. But there is something overall that creates the difference in charge. Think about the opposite of the voltage being used up.

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** You are right that friction needs to present. But in order for that to happen what else needs to be the case?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** Fine. That's the used up part. But what creates the difference in charge in the circuit overall? It's the ...

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 4 (D.2.2)

(8)

Teacher: OK, you seem to be getting the hang of it all now, you just need to believe in yourself. We still have plenty of time, so don't rush, because this is not obvious stuff and it's crucial that you understand it properly.

Teacher: Now, can you tell me what current is?

Student *(not confident)*: Yes...it's the movement of electricity through the wires, or something like that. (PARTIALLY CORRECT: the correct answer is: the flow of electrons through the circuit)

CHOICE 1 **Teacher:** Well, how would that work exactly?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** Yes, your answer is a bit vague, because the word 'electricity' isn't really a term we use often – in fact, we don't have it as one of our basic definitions. But you got the idea of movement of something to do with electricity through the wires. That was good. A more accurate answer is: the flow of electrons through the circuit.

Not appropriate	1	2	3	4	5	V. appropriate

<u>CHOICE 3</u> **Teacher:** Well, we don't refer to "electricity" as such, instead we're use another term. Can you remember what it is?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 5 (D.1.2)

(2)

Teacher: OK, you seem to be having a bit of a problem with this task. There's no rush, so take your time now especially that this bit is not immediately obvious. It's not too crucial for you to get this right straight away as we can come back to this a bit later.

Teacher: Let me give you a hint.

Teacher: Do you know what the value of the resistor you are looking for?

Student: No.

Teacher: OK, that's what you need to figure out first. Let us think about this step by step. What do we know about the relationship between resistance, current and voltage?

Student: Is it that the resistance times the voltage gives you the current ? (INCORRECT: the correct answer is E= I*R, i.e. voltage = current times resistance).

<u>CHOICE 1</u> **Teacher:** Well you know that resistance in a component tends to oppose current flow, but you seem to be suggesting that more resistance permits more current (RE = I)? Can that be right?

Not appropriate	1	2	3	4	5	V. appropriate

<u>CHOICE 2</u> **Teacher:** Are you sure about that? Why don't you try plugging a value

into the formula and checking it?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** But isn't the formula saying something about what the voltage equals to?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 1 (D.3.3)

(9)

Teacher: You're doing really well so far and you seem quite confident with the lab, but you must focus for a little bit longer, as this bit is important for you to understand all the other topics we need to cover today. It's not too difficult, so you should be OK.

Teacher: What do you know about what the resistance has to be from the relationship between voltage and current?

Student *(bored)*: 2500. (CORRECT)

Teacher: OK, the resistor you want could be 2500 ohms. What would happen if the resistance was less than this? Don't rush – we still have a little bit of time left.

Student *(confident)*: You would generate less current. (INCORRECT: *more current would be generated*)

CHOICE 1 **Teacher:** You are doing well, but it would generate more current.

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** Did you think that through? You calculated the resistance OK from the values of current and voltage. Do the calculation with the current a little bit slower and tell me what value of resistance you get. Is the resistance less than 2500?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** So, let us think about what value of the resistance you'd get. Would it be less than 2500 ohms?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 2 (D.5.3)

(17)

Teacher: You're doing really well. You just need believe in yourself a bit more. We still have to accomplish a few things today, so I need you to focus for a little bit longer. Can you do that?

Student *(interested)*: Yeah, this is actually interesting.

Teacher: OK, so the friction opposes the force – if there was enough friction it would prevent the box from moving or it would slow the box down. In either case, could you say that, in a way, the friction was "using up" the force you excerted?

Student: yes.

Teacher *(running out of time)*: So, the voltage is being "used up" in the light bulb. And that creates a complementary difference in charge. It is important to know this for future labs.

Teacher: OK, so now that you know what's happening to voltage in a light bulb, it shouldn't be too difficult for you to tell me what are the two conditions under which you get a difference in charge?

Student *(not confident)*: I'm not sure. Under the condition that friction is present? (PARTLY CORRECT: the student gave one condition. The desired answer is : if the voltage is either created or used up.)

CHOICE 1 **Teacher:** Can you tell me how would that on its own create the difference in charge? Would it create the voltage? Would it use it up? Both? Or neither?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** What do we know about the complementary conditions?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** That's one condition. But we said it was complementary. There's one condition giving rise to a difference in charge which is, if you like, the reason for this complementary change being present? What do you think?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 3 (D.2.3)

(20)

Teacher: OK, try to stay calm, I'm sure you will eventually understand all this, you just need to believe in yourself. We do have a lot to get through today, but we still have plenty of time, so don't rush, because this is not obvious stuff and it's crucial that you understand it properly.

Teacher: Now, can you tell me what current is?

Student *(not confident)*: Yes...it's the movement of electricity through the wires? (PARTIALLY CORRECT: the correct answer is: the flow of electrons through the circuit)

CHOICE 1 **Teacher:** Are you sure that it's the electricity? Why don't you have another look at the lesson we just covered?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** But isn't it something else than electricity that is flowing through the circuit?

Not appropriate	1	2	3	4	5	V. appropriate

<u>CHOICE 3</u> **Teacher:** That's fine. A bit imprecise – because we haven't really defined what electricity is – but if you substitute 'electrons' for 'electricity' – you're there. You got the movement part OK. That was good.

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 4 (D.4.3)

(13)

Teacher: You're doing really well, we still need to clarify a few simple things which are nevertheless important.

Teacher: Since we're running out of time, can you briefly explain how to observe polarity?

Student *(bored)*: Yes, that's just making sure the positive wire is connected to the positive side and vice versa (CORRECT)

Teacher: OK, then, something more difficult: if the red lead were connected to the tab number 3 and the black lead to number 4, which tab positions would be included in the negative side of the circuit?

Student *(not confi dent)*: Ehmm ... The number 4 tab? (PARTIALLY CORRECT: *the negative side of the circuit would span from tab 3 to 6*)

CHOICE 1 **Teacher:** That seems sensible. So convince me. How did you come to that conclusion?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** Can you tell me whether it's the only tab on the negative side? Would other tabs be included too? Are the other negative tabs to the left of tab 4? Or to the right of it?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** What gives you the idea that tab 4 would be in the negative part?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 5 (D.1.3)

(3)

Teacher *(running out of time)*: OK, you seem to be having a bit of a problem with this task. Since this is not immdiately obvious and it's important that you understand this before we move on to other things we still need to cover, let me give you a hint.

Teacher: Do you know what the value of the resistor you are looking for?

Student: No.

Teacher: OK, that's what you need to figure out first. Let us think about this step by step. What do we know about the relationship between resistance, current and voltage?

Student: Is it that the resistance times the voltage gives you the current ? (INCORRECT: the correct answer is E= I*R, i.e. voltage = current times resistance).

CHOICE 1 **Teacher:** You really need the resistance R on one side by itself for the calculation. So what would you do given the current I and the voltage E to calculate R?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** Are you sure about that? Why don't you try plugging a value into the formula and checking it?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** But isn't the formula saying something about what the voltage equals to?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 1 (D.3.4)

(10)

Teacher: You're doing really well so far so you should really start to believe that you can do it. Now, you must focus for a little bit longer as this bit is important for future labs and it's not very obvious.

Teacher: What do you know about what the resistance has to be from the relationship between voltage and current?

Student *(bored)*: 2500. (CORRECT)

Teacher: OK, the resistor you want could be 2500 ohms. What would happen if the resistance was less than this? Don't rush – we still have a bit of time left.

Student *not confident*: You would generate less current, perhaps? (INCORRECT: *more current would be generated*)

CHOICE 1 **Teacher:** Can you tell me why it would generate less current? If the resistance is less then is the opposition more? Less? Or neither?

Not appropriate	1	2	3	4	5	V. appropriate

<u>CHOICE 2</u> **Teacher:** Very close, it would generate more current.

Not appropriate	1	2	3	4	5	V. appropriate

<u>CHOICE 3</u> **Teacher:** Why would that be the case? Your answer was a bit tentative, so perhaps you're not too sure?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 2 (D.4.4)

(14)

Teacher: You're doing really well, and we managed to clarify a number of important things. So well done.

Teacher: Now, since we're running out of time, can you briefly explain how to observe polarity?

Student *(interested)*: I think so: that's just making sure the positive wire is connected to the positive side and vice versa (CORRECT)

Teacher: OK, then, if the red lead were connected to the tab number 3 and the black lead to number 4, which tab positions would be included in the negative side of the circuit?

Student *(not confident)*: I think maybe the the tab 4. (PARTIALLY CORRECT: *the negative side of the circuit would span from tab 3 to 6*)

CHOICE 1 **Teacher:** You are right that tab 4 is on the negative side of the circuit. But is it the only tab on that side?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** You are on the right track. Tab 4 is on the negative side of the circuit. But there are other tabs which belong with tab 4. Can you guess which ones?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** Good. That's certainly on the negative side of the circuit. So you've found one position. What, if you like, is the 'most negative' point in the circuit, or better perhaps, the last possible negative point in the circuit?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 3 (D.1.4)

(4)

Teacher: It's very important that you understand this before we move on with the lesson. Although we covered most of the lab, we don't have much time left, so I may have to help you a bit, OK? Ok, this bit may be a bit confusing at first.

Teacher: Do you know what the value of the resistor you are looking for?

Student: No.

Teacher: OK, that's what you need to figure out first. Let us think about this step by step. What do we know about the relationship between resistance, current and voltage?

Student *(confident)*: The resistance times the voltage gives you the current (INCORRECT: the correct answer is E= I*R, i.e. voltage = current times resistance).

<u>CHOICE 1</u> **Teacher:** You don't seem to have any doubt about that. Can you tell me where that answer came from? Did you just know it or did you just work it out?

Not appropriate	1	2	3	4	5	V. appropriate

<u>CHOICE 2</u> **Teacher:** No, that's still not right.

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** Actually, the formula says something different. Can you see that now?

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 4

(D.5.4) **(18)**

Teacher: Since we're running out of time here and I still want to talk about a few things, I'll tell you this bit. Don't worry if you don't understand this completely at first, it is useful to know it for future labs, but it's not essential immediately. OK?

Student: OK.

Teacher: OK, then. The friction opposes the force – if there was enough friction it would prevent the box from moving or it would slow the box down. In either case, could you say that, in a way, the friction was "using up" the force you excerted?

Student: yes.

Teacher *(running out of time)*: Good. A lot of people find this difficult. OK, so that's what's happening to voltage in a lightbulb. It is being "used up". And that creates a complementary difference in charge.

Teacher: OK, so now that you know what's happening to voltage in a light bulb, can you to tell me what are the two conditions under which you get a difference in charge?

Student *(confi dent, but obviously bored)*: Under the condition that friction is present. (PARTLY CORRECT: the student gave one condition. The desired answer is : if the voltage is either created or used up.)

<u>CHOICE 1</u> **Teacher:** You are right that friction is one condition. But there is another condition that is needed to create the difference in charge.

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** Yes, that's one. And what's the other – the most important charge difference in the circuit?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** Well, we said that there were two conditions.

Not appropriate	1	2	3	4	5	V. appropriate

Dialogue 5 (D.2.4)

(6)

Teacher: What you just said wasn't quite right, but I understand it may not be too obvious at first. Although we're running out of time, but it's very important that you understand this bit before we finish for today. So try to focus for a bit longer.

Student *(bored)*: OK.

Teacher: We know that there is a relationship between voltage, current and resistance. It is not as you said resitance times voltage = current. Can you guess what it is instead?

Student *(not confident)*: Ehmm... the voltage times the current gives you the resistance? (INCORRECT: the correct answer is E=I*R. The student has the correct formula in front of him).

CHOICE 1 **Teacher:** Actually, the formula says something different. Can you see that now?

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 2 **Teacher:** Well, you have the formula in front of you. So you should have referred to that. If in doubt, look it up, if you can.

Not appropriate	1	2	3	4	5	V. appropriate

CHOICE 3 **Teacher:** So, let us think about what would happen if we increased the resistance.

Not appropriate	1	2	3	4	5	V. appropriate

Appendix D

Case Base of Surface Forms used in the implementation of the system

Case-1: Very close they, will be 10 or less. 0.4,0.0

Case-2: You are right that increasing voltage is one option. But if you were to keep voltage constant what could you do to increase the current?. 0.7,0.533

Case-3: It sounds like you must be getting confused somehow. What does the power supply tell you? 0.575,0.233

Case-4: Well, we said that there were 2 alternative ways to increase power. 9,0.433

Case-5: Well, let us try it. 0.8,0.533

Case-6: What to we know about the relationship? 0.75,0.33

Case-7: OK, Let us do this step by step + lecture + O-T-Q. 0.7,0.3

Case-8: So, Let us think about what has to be true in order to get a voltage reading that isn't 2000? 0.75,0.33

Case-9: Let us try again. Say, the black lead is connected to the 4 tab. Which tab positions would be included in the positive side of the circuit? 0.7,0.33

Case-10: Let us try to step through this one step at a time. You already said that you want to calculate power by multiplying current times voltage. Voltage then would be power devided by current. But you don't know what the current is. However you can make up a formula. [given all this] what formula do you get for current? 0.7,0.266

Case-11: How would it [the current] flow? Through only the wire? Or through only the meter? 0.3,0.4

Case-12: Can you tell me how current would flow? Would it flow through wire? Or only through the meter? Or through both? Or through neither? 0.3,0.3

Case-13: You are right that increasing voltage is one option. But if you were to keep voltage constant, what could you do to increase current? 0.7,0.6

Case-14: Are you sure about that? Why don't you try plugging a value into the formula and checking it? 0.55,0.733

Case-15: You are on the right track. You need to calculate current, but you don't have enough information to get a specific value. However, you can find out how it relates to one other variable. Can you guess which one? 0.75,0.5

Case-16: If you have a resistor of less than 2000 ohms and a voltage of 10 volts, how much current will you have? 0.9,0.5

Case-17: OK, that's one way, but there is another way that is more helpful. Think about the other relationship you know about. 0.75,0.3

Case-18: You are very close, but if E=IR, how can I=ER? 0.6,0.6

Case-19: Now explain to me how you are trying to solve this problem. It looks like you were close to being on the right track. What are you trying to solve for? 0.46,0.84

Case-20: Ok, try to explain to me how you are solving this problem. 0.2,0.8

Case-21: Why do you think so? 0.2,1.0

Case-22: Well, what exactly wouldn't work? 0.375,0.8

Case-23: And why do you say that? 0.425,0.866

Case-24: Why? 0.2,1.0

Case-25: What gives you the idea that the rheostat tells you what the current is? 0.3,0.8

Case-26: What do we know about the relationship between resistance, current and voltage? 0.75,0.33

Case-27: What would have happened if you had left wire 3 in? 0.3,0.4

Case-28: Isn't the wire already in the circuit? 0.2,0.1

Case-29: But isn't the switch also permitting the electrons to flow? 0.25,0.2

Case-30: Actually, current is not flowing at the moment, because the switch is turned off. Can you see that now? 0.433,0.225

Case-31: No, I is current. That's what you just said. Try again. 0.2666,0.3

Case-32: No, but you're close. Go look once more and then try again. 0.366,0.233

Case-33: You are very close, but I=E/44, and P/I does not equal I. 1.0,0.533

Case-34: No, but you're close. 0.45,1.0

Case-35: No that's still not right. 0.325,0.9333

Case-36: You don't need to connect them to those exact tabs. You just need to be sure to observe polarity. Can you explain how to observe polarity? 0.4,0.3

Appendix E

Published papers

Earlier versions of the work referred to in this thesis were produced in the form of three workshop papers and publications.

Papers referring to some of the material presented in Chapter 3 were presented in the following papers:

Porayska-Pomsta, K., Mellish, C., Pain, H. (2000) Aspects of Speech Act Categorisation: Towards Generating Teachers' Language. *International Journal of Artificial Intelligence in Education*, **11**(3), 254-272.

Porayska-Pomsta, K., Pain, H., Mellish, C. (1999) Why do teachers ask questions? - a preliminary investigation. In the proceeding of the workshop on *Analysing Educational Dialogue Interaction*, International Conference on AI in Education, Le Mans.

The paper referring to the first pilot of the exploratory study with teachers which is discussed in Chapter 5 was presented in:

Porayska-Pomsta, K., Mellish, C., Pain, H. (2000) Pragmatic Analysis of Teachers' Language. Towards an Empirically Based Approach. *Proceedings of AAAI Fall Symposium on Building Dialogue Systems for Tutorial Applications*. Cape Cod, Massachusetts.

Copies of all of the papers are included at the back of the thesis.